The Agricultural Journal of India

VOL. XVIII

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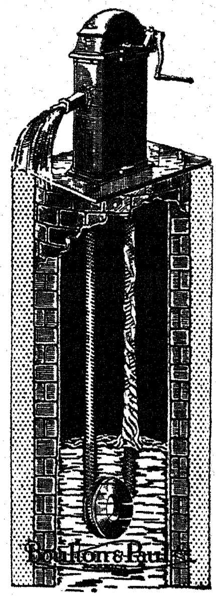

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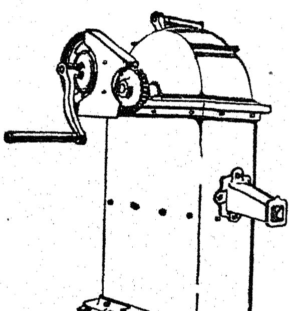

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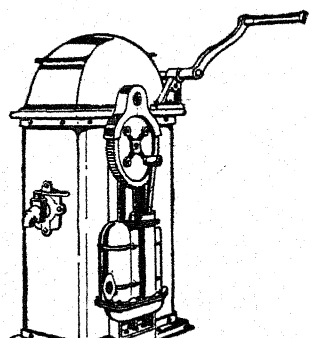

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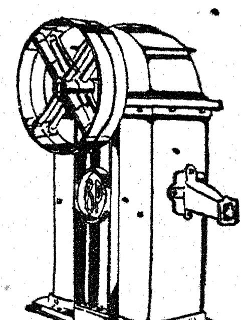

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Original Articles

SOME COMMON INDIAN BIRDS.

No. 24. THE BENGAL TREE-PIE (*DENDROCITTA RUFA VAGABUNDA*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist;

AND

C. M. INGLIS, M.B.O.U., F.E.S., F.Z.S.

THE true Crows, as anyone may observe, have tails which are much shorter than their wings, but many members of the great Crow family have tails much longer than their wings, and this latter group includes the Magpies and Tree-Pies, of which a dozen species occur within our limits, mostly in the Hill Districts of Northern India. The Tree-Pie, however, is rather a bird of the Plains, where it is sufficiently common to be a familiar object in most large gardens, although its curiously metallic cry, rather like the loud squeak from a rusty gate-hinge, if one may imagine a mellifluous squeak, is usually more evident than the appearance of the bird itself. Its most usual call is a sound which may be written *kok-lí, kok-lí*, but it has a great variety of notes, many of them charmingly melodious in character, others merely hoarse chattering volleys of sound. So far as appearance goes, the Tree-Pie can hardly be mistaken for any other bird found commonly in the Plains, being about eighteen inches long, of which two-thirds is tail, the bill black, the head, neck and breast sooty-brown, the body

chestnut-reddish, with some silver-grey on the wings, and the long tail greyish, darkest at the base and broadly tipped with black. During flight the tail is spread out and, as the tail-feathers are unequal in length, the middle feathers being the longest and the others decreasing in length to the outer pair, which are only about half the length of the middle ones, the expanded tail gives this bird a curious appearance when on the wing. Like many other birds, the Tree-Pie has split up into several local races, of which five have been given sub-specific names. Of these, however, three, distinguished by the blending of the colours of the head and back, are confined to Burma and need not be more than alluded to here. The two Indian forms, in which the colours of the head and back contrast strongly, are the Indian Tree-Pie (*Dendrocitta rufa rufa*) which is lighter both above and below and not nearly so richly coloured as the Bengal Tree-Pie (*Dendrocitta rufa vagabunda*) which is darker and more richly coloured both above and below. The former race is found throughout the whole of Southern India as far North as Orissa and in Sind, Afghanistan, and the Punjab as far as Garhwal. The Bengal race occurs from Garhwal to Eastern Assam, throughout the United Provinces, Bihar and Bengal, and is the form figured in our Plate. The habits of both these Indian races, however, are quite similar and both may be considered together under the general name of the Tree-Pie.

The Tree-Pie is a bold and intelligent bird, which goes about in pairs or in small parties, flying from one tree to another and continually prying about for insect or vegetable food. In the early morning especially it is often seen in trees on the hunt for insect food ; it is a good climber and supports itself with its claws and tail, rather like a wood-pecker, on vertical or even overhanging stems and branches whilst it searches the crevices of the bark for small insects. Some of its food is obtained on the ground, but most in trees and bushes, and a very small proportion on the wing. The late C. W. Mason stated that " this bird is to a very large extent a vegetable feeder, though it does not apparently damage crops or planted seeds. It takes a variety of weed seeds and fruits of all kinds including all the common species of *Ficus*, *ber* fruit (*Zizyphus*

jujuba), mulberries, *Sissu* seeds, etc. Of cultivated fruits, when they are in season, it takes peaches, loquats, plantains, etc., and besides eating the fruit on the trees it will often knock off a considerable amount more. Not only does it thus damage the fruit, but it also breaks off small branches (which often contain fruit buds) of brittle-wooded varieties of trees when it alights on them, and is therefore not to be desired in a carefully kept orchard. Leaves and buds of various sorts are also eaten, but apparently only of wild plants. The Tree-Pie's insect food is very varied, but undoubtedly some preference is shown to caterpillars, principally Geometrids and some other smooth varieties—I have never known it touch a hairy one—to beetles, which are mostly Tenebrionids, and to a less extent to the common wasp, *Polistes hebræus* . . . . . It does not as a general rule take crickets." It is fond of silk-worm caterpillars and, when it can obtain access to these, may be a nuisance to silk-worm rearers. The food, however, is very varied and one's impression is that it is more largely of an animal nature than Mr. Mason's records indicate. Lizards and spiders are greatly relished and a Tree-Pie will often make a regular practice of hunting around the verandah of a bungalow in the early morning to snap up any lizards or spiders which may be recovering from a surfeit on the insects attracted to the lights the night before. Mr. D'Abreu examined at Nagpur a bird whose stomach contained a mouse, a Buprestid beetle, a caterpillar and two Pentatomid bugs, and at Pusa I have seen one carrying a very fair-sized snake which I managed to make the bird drop and found it to be a *Tropidonotus stolatus*, upwards of two feet long; the snake when rescued was alive and active but bore marks of the bird's mandibles and would undoubtedly have been eaten. The Tree-Pie is also a confirmed robber of the nests of other birds, especially of doves, stealing and devouring the eggs and young of all the smaller birds. Like many other birds, the Tree-Pie has his good and bad points, but on the whole it is apparently beneficial.

The breeding-season is from February to July, from February to March in the South and from May to July in the North, but is not well-defined and eggs may be found both later and earlier

than the period normal to any particular locality. The nest is usually placed well up in a large tree but may at times be built in a thorn hedge, thorny bush or in a cactus clump. The nest is a not very large but rather untidy mass of twigs, roots and miscellaneous material, carelessly interwoven and lined with roots or at times with softer material. Three to five eggs are laid as a rule, most often four, rarely six, but in the South only two or three, and the eggs, which average about 29 by 22 mm., belong to two types, one pale greenish blotched and spotted with fuscous, the other pale reddish-white or salmon-colour with blotches of reddish and dark brown and other underlying blotches of lilac and neutral tint ; the former type is the commoner in North Bihar. The young birds are fed almost entirely on caterpillars and perhaps also on fruit to some extent.

The Tree-Pie has not been given legal protection in any part of India. Apparently it is considered well able to look after itself. Being conspicuous, it rejoices in various names in different parts of the country ; Stuart-Baker states that the Bengal race is called Bobalink by Europeans, but this name belongs rightly to an American bird and I have never heard it used in India, although it is to some extent descriptive of the Tree-Pie's note ; in North Bihar the local vernacular name is *kokayā*, in Bengal it is also called *kotri*, *takka-chor* and *handi-chacha*, in North Cachar *kash-kurshi*, in Assam *khola-khoa*, in Hindi-speaking areas *maha-lat*, at Lucknow *mutri*, in Sind *mahtab* and *chand*, and in Telugu-speaking districts *gokurayi* and *kond-kati-gada*. It will be noted that many of these vernacular names are also expressive of the various calls uttered by this bird.

SOME ECONOMIC PLANTS OF THE NAGA HILLS.*

BY

J. H. HUTTON, C.I.E., M.A., I.C.S.,
Deputy Commissioner, Naga Hills, Assam.

I OUGHT at the outset to state that I am no botanist. The plants and trees subsequently mentioned have been identified for me by Mr. A. C. Tunstall of Toklai. I did not even collect them all myself, as Mr. H. G. Dennehy collected many of them and Mr. J. P. Mills others. The real justification of this paper is less that it may impart information than the hope that it may elicit it.

The area from which these plants come is that of the range of hills separating Assam from Burma, the highest peak of which is Sarameti—12,000 feet. The fauna, at any rate, of this area combines Himalayan with Burma types, a statement which applies to the human as well as other varieties, as the wild tribes inhabiting these hills are of exceedingly mixed origin. At the same time, they have probably changed little since Ptolemy wrote of their habitat as the "kingdom of nakedness" some 1,600 years ago. Some of the tribes still go stark naked in their villages and even when visiting the plains of Assam to trade.

The Chăng Naga tribe has a tradition that the wearing of clothes began by the use of nets for the carrying of children by their mothers who needed both their hands for work in the fields. However this may be, it seems likely that the use of fibre preceded that of cotton in their case, as some villages which can get cotton do not spin or weave it, although they do spin and weave in fibres. These fibres are usually made from the covering of the stalk immediately under the bark. The fibres actually in use for making

* Paper read at the Botanical Section, Indian Science Congress, 1923.

cords and nets are obtained from the following plants among others :—

(1) *Hibiscus macrophyllus* Roxb., a small slender-stemmed tree growing in warm low land, but not in forest, and used for making slings to carry burdens with, and for rope to tie cattle.

(2) *Sterculia villosa*, an inferior sort of tree also usually found at low levels and in abandoned cultivation, but occasionally in forest also, and used for the same purposes as the preceding, and for coarse string bags.

(3) *Grewia macrophylla* Don., a small tree growing on cliffs and bearing white flowers in June, used for the same purposes as the last. The Ao Naga name is *lungpangsongtong*, meaning "the precipice tree".

Finer net bags, fishing nets and net purses for carrying money are made from the fibre of (4) *Triumfetta pilosa* Roth., a straight-growing shrubby plant with one stem, found in recently abandoned fields and bearing a few large burrs.

Fishing nets, cords for various purposes and bow-strings are made from the fibre yielded by (5) *Villebrunea integrifolia* Gaud., a small tree growing in stoney ground at lowish elevations and usually near water. This fibre used to be used, according to tradition, for making thread and cloth, a tradition which also attaches among the Ao Nagas to (6) *Urtica parviflora* Roxb., a branched shrub with stinging-nettle leaves bearing a drooping spike of green flowers in August and generally found in places frequented by man.

A second nettle is (7) *Girardinia heterophylla* Dcne., flowering in September with a long drooping spike of green flowers and habits like the preceding. It has a fine silk-like fibre likewise used for thread in Ao tradition, and is a small straight-growing shrub with leaves which the Nepalis eat as a vegetable, but which sting very severely, whence its Ao name of the "iron nettle", *merang taklemtso.*

A different sort of plant also traditionally used for cloth is (8) a dwarf *Hibiscus* bearing flowers in July which change from pink to yellow. This plant is still occasionally used for making cords for carrying loads, and is known to the Aos as *mésukámba*, "the deer's cotton-plant."

Another plant, the use of which (for making thread and cloth) is traditional only, is (9) *Sterculia colorata*, a big forest tree bearing red flowers in August so prolifically that the Aos call it *methang*, "reverberation". It grows in forest land chiefly near water and at any height up to about 4,000 feet.

Yet another is (10) *Urena lobata* Linn., a branching shrub with pink flowers that give place to prolific burrs, so much so that the Ao name for the plant is *kūmenátsu*, "adhering to the hair".

So far all the plants said to be used for thread and cloth are only traditionally so, but further south we find the Ăngāmi Nagas actually using three plants from which thread and cloth are still regularly made. It is perhaps worth noticing that the general culture of the Ăngāmis is higher than that of the Aos, which suggests that the Aos have lost the use of their traditional fibres by a decline rather than an elevation of culture. Both tribes spin and weave in cloth, though the Ăngāmi work is distinctly superior. The fibre plants still regularly used by the Ăngāmis are *Pouzolzia viminea* Wedd., the fibre of which is used for making a coarse but very lasting cloth, and *Girardinia heterophylla*, the stinging nettle already mentioned (No. 7) with a large three-pointed leaf, and *Bœhmeria platyphylla*, a "dead nettle" with a single-pointed leaf, both of which I have seen growing up to a height of about 7,000 feet. These two yield a finer thread than the first; it is mixed with cotton and woven into an excellent white cloth. The last-mentioned of the three, however, seems to be going out of use for some reason which I have been unable to find out definitely.

In addition to the foregoing, *Pueraria thomsoni* Bth., or perhaps *P. thunbergiana*, if not both, is used by Sĕma and Lhōta Nagas to provide a fine cord for making heddle strings for looms. It is a creeper bearing bunches of deep purplish blue wisteria-like flowers in October. With the exception of this plant, the fibre plants which I have mentioned are given by Watt in *Economic Products of India*, but unfortunately he does not always say whether the quality of the plant mentioned is known to the inhabitants of the localities in which it is found, or who those inhabitants are. He does not always seem to give the locality, and in any case deals with India only.

The use of jungle fibres for cord, nets and ultimately cloth is perhaps in no way remarkable, and it is perhaps natural that with the introduction of cotton the use of fibres for cloth should disappear. The use of plants for dyeing, however, is a different matter, as the processes are some of them very complicated. In all cases the material to be dyed is boiled with the bark, wood, leaves or fruit, more often one of the two former, of the plant that yields the dye. In some cases this is enough to give a fast colour, in others the addition of a second plant as a mordant is necessary, in yet others a double process is required, the material having to be dyed a different colour first and then redyed to get the desired tint. The dyes used by the Ăngāmi Nagas are not very numerous and some of them are well known. The plants that follow are all mentioned by Watt, though in the case of *Macaranga denticulata* and *Rhus semi-alata* he does not mention that they have any properties of value in dyeing. The Ăngāmis cultivate *Strobilanthes flaccidifolius* Nees for the dark blue and black colour which it yields; red they obtain from *Rubia cordifolia* L. and from *R. sikkimensis* Kurz, yellow from *Berberis nepalensis* Spreng., all wild plants. As a deep red cannot be obtained from madder alone, the material is first dyed yellow with *Symplocos grandiflora* Wall. or *S. spicata* Roxb., and then redyed with one of the madders. A sort of drab fawn dye is obtained from *Cordia Myxa* L., the leaves giving a darker tint than the bark. As mordants *Macaranga denticulata* Müll Arg., *Morinda angustifolia* Roxb. and *Rhus semi-alata* Murr. are used, each with the dye to which it is suited; thus *Macaranga* is used with *R. cordifolia*, and *Morinda* or the berry of *Rhus* with *R. sikkimensis*. With *Strobilanthes*, *Berberis* and *Cordia Myxa* no mordant is necessary. To dye a fast lamp black the material is first boiled with *Macaranga denticulata* and then dried off, the remaining liquid being mixed with a black mud in which the material is again steeped. The iron salts in the mud act on the gallic acid in the *Macaranga* and produce a fast deep black.

Perhaps the most interesting point about these processes is the question of how they come to be known to these decidedly primitive tribes, whose communication with the outside world seems

to have been almost nil until quite recently, at any rate for a very long period of history indeed. If botanists could state for the benefit of anthropologists in what other parts of the world, in particular, parts other than Assam, India and Burma, the dyes and fibres used by Naga tribes are actually used or are known to tradition, the information would be of the greatest value in determining the affinities of Naga culture.

LINKAGE RELATIONS IN THE COTTON PLANT.*

BY

K. I. THADANI, M.Sc. (Texas), B.Ag., F.L.S., F.R.H.S.,
Cotton Breeder in Sind.

The discovery that the development of certain characters in organisms is linked with that of certain other characters has been one of the most interesting results which have followed from the vigorous study of the problems of heredity in recent years. But so far little work in this direction has been done in the case of the cotton plant. And yet there is a very wide-spread belief among those who have grown the crop that such linkages occur in this case. It is, for instance, generally believed that a cotton seed which gives a high percentage of lint (ginning percentage) is not likely to be a cotton of long staple. This particular point is one which I have not yet been able to study, but I have to place several clear cases of similar linkages which I have observed in studies on American cotton.

Single linkage.

Case 1 (*a*). *Linkage of seed fuzziness and amount of lint on the seed in cotton.*

The factors involved are (A) which determines the naked condition of the seed-coat and its allelomorph (a) representing fuzzy seed ; (B) represents high amount of lint and (b) low amount. Both of these characters are easily distinguishable by the naked eye. The parents involved in the crosses are Naked low (Ab) and fuzzy High (aB). The F_1 hybrid is Naked High (AB) and in F_2 the segregation is in the ratio 2 Naked High (AB) : 1 Naked low (Ab) :

* Paper read at the Botanical Section, Indian Science Congress, 1923

1 fuzzy High (aB) : 0 fuzzy low (ab) as per data given in the following table.

TABLE I.

F_2 segregation of cross Naked low (Ab) × fuzzy High (aB).

Serial No.	Cross	No. of individuals: Naked High (AB)	Naked low (Ab)	fuzzy High (aB)	fuzzy low (ab)	Total No.
1	No lint × Lonestar ..	9	5	5	0	19
2	No lint × Texas rust ..	27	14	14	0	55
3	Acala × No lint ..	34	19	18	0	71
4	Acala × No lint ..	33	16	16	0	65
Observed totals		103	54	53	0	210
Ratio		2	1	1	0	
Calculated on independent segregation		118·1	39·4	39·4	13·1	210
Calculated on complete linkage ..		105	52·5	52·5	0	210

The calculated ratio based on independent segregation falls short of agreement with the observed totals ; even though when each pair of characters is considered separately the agreement with the monohybrid ratio is very satisfactory. Thus for Naked and fuzzy characters the observed totals are 157 : 53 and for High and low amount of lint the observed totals are 156 : 54, which are a very close fit for a 3 : 1 ratio. Taking each pair separately, the factors evidently segregate in the normal Mendelian fashion ; but the excess of the parental types and the corresponding reduction in the F_1 type and also the total absence of the fourth phenotype (fuzzy low) composed of both recessive members of these two pairs of characters in the F_2 generation indicate that the factor (A) representing Naked condition of the seed-coat and factor (b) representing low amount of lint, which both came from one parent, and their allelomorphs (a) and (B), which came from the other parent, do not get separated ; and the observed totals are in agreement with the expectations on the basis of complete linkage. The factors, therefore, seem to

display complete linkage. Further evidence of this conclusion was obtained from the behaviour of the F_3 generation as shown in Table II.

TABLE II.

F_3 generation of the cross Naked low (Ab) × fuzzy High (aB).

Phenotype	No. of F_2 individuals tested	Behaviour of progeny F_3	Genetic constitution
Naked High (AB) ..	103	All individuals heterozygous for both factors	A a B b
Naked low (Ab) ..	54	All individuals homozygous ..	A A b b
fuzzy High (aB) ..	53	Ditto	a a B B

The above table shows that F_1 type, that is to say, the Naked High (AB), can only exist in heterozygous condition and it is impossible to breed that type in homozygous state. Further, the parental types obtained in the F_2 generation refuse to split in the F_3 generation without exception, and breed true to type; which is quite contrary to simple Mendelian inheritance, in which case we must expect a certain proportion of the individuals proving to be heterozygous for the dominant factor. The results obtained justify the conclusion that the factors (A) and (b) and *vice versâ* (a) and (B) are completely linked without any cross-over * which accounts for the absence of double-recessive (ab) fuzzy low type.

Case I b. A cross involving three pairs of factors two of which are linked.

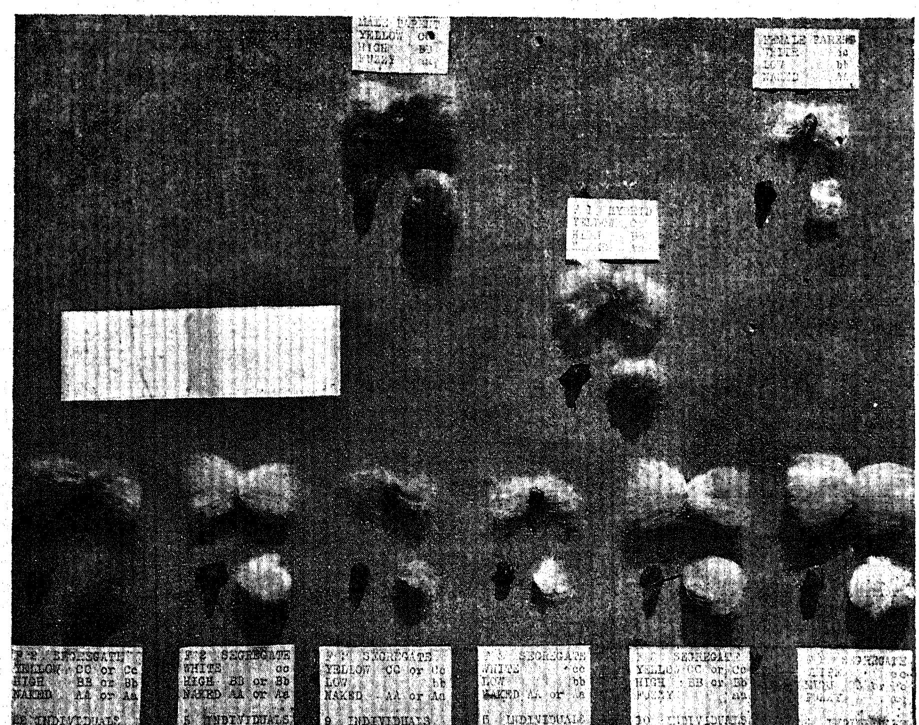
One of the parents called "Texas Rust" has fuzzy seed represented by factor (a), high amount of lint (B), yellow cotton (C). Thus the phenotypic formula of this parent would be (aBC). The other parent called "No lint" has Naked seed (A), low amount of lint (b) and white cotton (c). Thus its phenotypic formula would be (Abc). In the cross aBC × Abc the F_1 hybrid is ABC and F_2 segregation is given in Table III (Text-fig.).

* The possibility of a minute percentage of cross-over has still to be ascertained by growing a larger population.

TABLE III.

F_2 segregation of cross Naked low white (Abc) × fuzzy High Yellow (aBC).

Phenotype	Phenotypic formula	No. of individuals observed
Naked–High–Yellow	ABC	22
Naked–High–white	ABc	5
Naked–low–Yellow	AbC	9
Naked–low–white	Abc	5
fuzzy–High–Yellow	aBC	10
fuzzy–High–white	aBc	4
fuzzy–low–Yellow	abC	0
fuzzy–low–white	abc	0
TOTAL	..	55



No Lint × Texas Rust.

Top—Parents; Middle—F_1 hybrid; Bottom—F_2 generation (there were no individuals in two segregates—Yellow CC or Cc, low bb, fuzzy aa; and white cc, low bb, fuzzy aa).

Each individual section in the row shows: Top—seed cotton; Bottom left—seed; Bottom right—lint from one seed.

When each pair of characters is considered separately, the agreement with monohybrid ratio is satisfactory; the observed totals for each of the three pairs of characters being 41 : 14. The ratio is a very close fit so that if only one individual were added to the dominant class it would be a perfect 3 : 1 ratio. But when two pairs of factors are considered in relation to one another, the following dihybrid ratios are obtained.

TABLE IV.

F_2 dihybrid ratios in the cross Abc × aBC.

Dihybrid combinations		Phenotypes	Observed totals	Ratio
No.	Formula			
	Ab × aB	AB : Ab : aB : ab	27 : 14 : 14 : 0	2 : 1 : 1 : 0
2	Ac × aC	AC : Ac : aC : ac	31 : 10 : 10 : 4	9 : 3 : 3 : 1
3	bc × BC	BC : Bc : bC : bc	32 : 9 : 9 : 5	9·3 : 2·6 : 2·6 : 1·5

The above table shows that the factor for colour when considered in relation to the other two factors seems to display simple Mendelian inheritance, but the factors for seed fuzziness and amount of lint display complete linkage. This conclusion was confirmed by the study of the behaviour of the various phenotypes in the F_3 generation which has been described in Table V.

TABLE V.

F_3 generation of the cross Abc × aBC.

Phenotype	No. of individuals tested	Formula	Behaviour	Genotypes represented in the group
Naked-High-Yellow	22	ABC	Some individuals heterozygous for A and B only	Aa Bb CC
			others heterozygous for all ..	Aa Bb Cc
Naked-High-white	5	ABc	All heterozygous for A and B ..	Aa Bb cc
Naked-low-Yellow	9	AbC	Some heterozygous for C only ..	AA bb Cc
			others homozygous ..	AA bb CC
Naked-low-white	5	Abc	All homozygous	AA bb cc
fuzzy-High-Yellow	10	aBC	Some heterozygous for C only ..	aa BB Cc
			others homozygous ..	aa BB CC
fuzzy-High-white	4	aBc	All homozygous	aa BB cc

Case 2. Linkage of vegetative colour with fruiting habit in cotton.

In a cross of "Red leaf" with several other American Upland cottons it is found that the red coloration of the plant is linked with cluster habit of fruiting as found in the "Red leaf" parent, and *vice versâ* green colour of the plant is linked with non-cluster habit of fruiting as found in many of the Upland cottons.

The factors involved are (G) for red colour, (g) its allelomorph for green colour, (D) for Non-cluster fruiting and (d) its opposite for cluster fruiting. In the cross Gd × gD, the F_1 hybrid is GD and F_2 segregation is given in Table VI.

TABLE VI.

F_2 segregation Red cluster × green Non-cluster.

Cross	No. of Individuals				Total
	Red Non-cluster (GD)	Red cluster (Gd)	green Non-cluster (gD)	green cluster (gd)	
Durango × Red leaf	64	23	29	0	116
Acala × Red leaf	22	10	13	0	45
Ditto	30	10	18	0	58
Rowden × Red leaf	20	5	13	0	38
Observed totals ..	136	48	73	0	257

The investigations in these crosses have reached this stage only; F_3 generation when raised would provide further material for determining the mode of inheritance in this case. From the results obtained it is evident that this is another case of linkage between two factors in cotton. Although the ratios in several crosses are rather disturbed, still considering the first two crosses in Table VI, they come almost near the mark on the basis of complete linkage.

Triple linkage in cotton.

In the cross "No lint" × "Red leaf," there are four factors involved, and three systems of linkage are found in one and the same cross. This cross is represented by the formula AbgD × aBGd. The F_1 hybrid is ABGD and the F_2 segregation is shown in Table VII.

TABLE VII.

F_2 segregation AbgD × aBGd cotton cross involving three systems of linkage.

Phenotype	Formula	No. of individuals
Naked–High–Red–Non–cluster	ABGD	16
" " " –cluster	ABGd	5
" " –green–Non–cluster	ABgD	15
" " " –cluster	ABgd	0
Naked–low –Red–Non–cluster	AbGD	6
" " " –cluster	AbGd	3
" " –green–Non–cluster	AbgD	10
" " " –cluster	Abgd	0
fuzzy–High –Red–Non–cluster	aBGD	14
" " " –cluster	aBGd	3
" " –green–Non–cluster	aBgD	5
" " " –cluster	aBgd	0
fuzzy–low –Red–Non–cluster	abGD	0
" " " –cluster	abGd	0
" " –green–Non–cluster	abgD	0
" " " –cluster	abgd	0
TOTAL	..	77

The F_2 segregation here displayed is not in accordance with the expectations based on independent distribution of the four pairs of factors involved in this cross, since only nine phenotypes have appeared. Evidently it is a case of linkage. In order to get an idea as to which factors are linked in this cross, we should examine dihybrid ratios as given in Table VIII which has been compiled from Table VII.

TABLE VIII.

F_2 dihybrid ratios obtained in cross AbgD × aBGd.

DIHYBRID COMBINATIONS		Phenotypes	Observed totals
No.	Formula		
1	Ab × aB	AB : Ab : aB : ab	50 : 19 : 22 : 0
2	gD × Gd	GD : Gd : gD : gd	36 : 11 : 30 : 0
3	bg × BG	BG : Bg : bG : bg	38 : 20 : 9 : 10
4	bD × Bd	BD : Bd : bD : bd	50 : 8 : 16 : 3
5	Ag × aG	AG : Ag : aG : ag	30 : 25 : 17 : 5
6	AD × ad	AD : Ad : aD : ad	47 : 8 : 19 : 3

The above table shows that, of the six possible dihybrid combinations in this cross, the last three seem to follow independent Mendelian inheritance although the ratio of 9 : 3 : 3 : 1 is greatly disturbed; the first three are apparently cases of linkage.

Conclusion.

In conclusion, it will be seen that there is evidence of the linkage of certain of the seed characters in American cotton. And this fact may be of great importance in breeding types of cotton of commercial value. In certain cases it will be impossible to combine characters, which may be desirable, and this should always be borne in mind by those who are studying the crop. In case two pairs of factors are completely linked, it will not be possible to obtain any combination other than the parental type. If partial linkage occurs, a much larger number of plants will have to be grown in the segregating generations than would otherwise be necessary in order to obtain the combination desired.

POLLINATION METHODS AMONGST THE LESSER MILLETS.*

BY

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THERE is a collection of food grain plants known as the lesser millets, called lesser because they are smaller in habit than the *juars* (*Andropogon Sorghum*) and *bajras* (*Pennisetum typhoideum*) which are the greater millets. They yield a small coarse grain and are only grown by the very poorest of the population in the poorest of soil which will grow practically nothing else; a hill slope that holds no water often being where they are grown. These lesser millets are all included in Hooker's Paniceæ which also includes the greater millet *bajra*. The Paniceæ are a very diverse group, and the various genera Hooker includes under this head do not appear in all cases to show close natural relationship. In one character the lesser millets, however, show considerable uniformity. They are mostly self-pollinated. The way in which this is attained is interesting in different cases. Self-pollination is as common amongst the lesser millets as it is rare amongst the greater.

Panicum miliare seems in nature to be almost entirely selfed in spite of numerous neighbours and what appears abundance of opportunity for cross-pollination. We experienced no difficulty in crossing it artificially, but we found the process of emasculation to be a very delicate operation. The difficulty is that the flower

* Paper read at the Botanical Section, Indian Science Congress, 1923.

rarely stands the treatment necessary to open the glumes in bud condition for the operation. In spite of this difficulty we did succeed in a few cases. Another method we employed for effecting cross-pollination more readily is the following, but very great care is required to avoid selfing. In this we allowed the glumes to open of their own accord and at once removed the anthers with fine forceps. Any spilled pollen grains we removed from the stigmas or other parts of the flower by a delicate spray of water from the fine jet of an ordinary chemical wash bottle.

In nature, crossing is prevented almost entirely by the short duration of time occupied in the blooming of the flower and also by the comparatively small number of flowers opening on a plant at the same time, so that any individual is not immediately surrounded by an enormous number of blooming neighbours. The time between the opening and closing of the flower we found to be from 15 to 20 minutes only. At Nagpur, the flowers open between 9-30 A.M. and 10-30 A.M., the actual time depending upon atmospheric conditions. The glumes open and gape apart, this being brought about by the expansion of the two lodicules at the base of the ovary which push the pales apart. The styles and anthers are packed inside the upper pale in a peculiar way. In a young flower the styles stand up like a pair of horns from the top of the ovary, with a slight bowing or curvature near their bases, the convex side being outwards (Fig. 1).

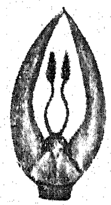

FIG. 1

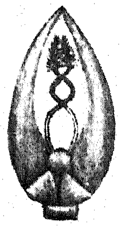

FIG. 2.

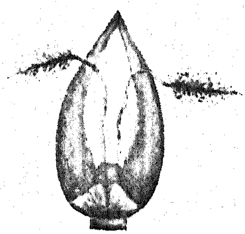

FIG. 3.
Stigmas protruding from the flower.

Panicum miliare; upper pale and stigmas only.

Later the styles elongate and the stigmas are arrested by the incurved edges of the apex of the pale. This causes the two actively growing styles to cross over each other twice, once at the top of the

original bowing and again just below the stigmas (Fig. 2). At the same time the anther stalks increase in length to such an extent that a kink appears in them (Fig. 5). The filament, as its length

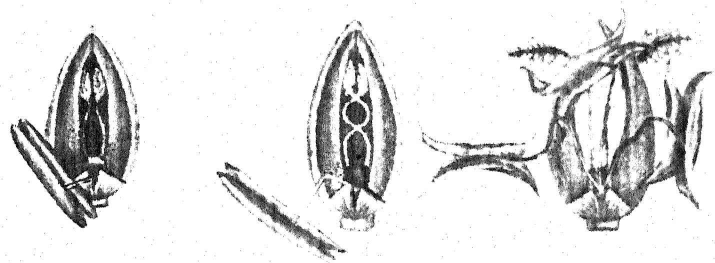

FIG. 4. Young stage; one anther taken out. Other two are behind the styles.

FIG. 5. Older stage showing increase in length of filament and its kink.

FIG. 6. Stage after opening of flower.

Panicum miliare; lower pale removed.

increases thus, becomes folded, but always remains elastic like a spring bent upon itself. The tension reaches such a pitch that on the commencement of the opening of the glumes, the styles and filaments, at once, with explosive suddenness, spring out. The flowers that are ready to bloom can be made to do so immediately by just drawing the inflorescence through one's closed hand, the slight pressure starting the springs to work, as it were. Soon after this, the anthers begin to burst, one after another, while still encircling the two stigmas. This bursting takes place by sudden spasmodic jerks and the pollen grains are thrown out with great force in all directions. As a result of this, the stigmas almost invariably get pollinated at a period within two minutes from the commencement of the opening of the glumes. The anthers, soon after bursting, shift their positions and in so doing rub against the stigmas and then fall out of the flower, assuming the pendant position. The glumes remain open for about 15 to 20 minutes and then close again, the stigmas generally remaining out on either side, rarely going back with the closing of the glumes. The crop, therefore, as a rule, is self-pollinated. The chances of cross-pollination come in only when the glumes have just opened,

and the blowing in of some foreign pollen on to the stigmas, before the bursting of the anthers, might effect it but it is rare.

In the case of *sawan* (*Panicum crus-galli*, var. *frumentaceum*), another of the lesser millets, which is also often used as a food crop, the pollination is slightly different. The flowers open much earlier, between 7-30 and 8-30 in the morning. The glumes open more slowly than in *Panicum miliare* and the stigmas and the anthers come out simultaneously through the opening of the glumes. The stigmas spread out immediately on either side, while the anthers hang about them without dehiscing for about 1 to 1½ minutes and then burst in the same jerky fashion as in *Panicum miliare*, throwing the pollen all around. They never assume the pendant position as in *Panicum miliare* but remain close to the stigmas until the flowers close back again after remaining open for about half an hour.

In *kodon* (*Paspalum scrobiculatum*), only about 5 per cent. of the flowers have been found to open at Nagpur, the rest are all cleistogamous, always remaining closed. The flowers that open, do so between 7-30 and 8 o'clock in the morning and remain open for about 20 to 30 minutes. Soon after the opening of the glumes, the anthers burst and the stigmas spread out on either side. Self-pollination takes place immediately and then the glumes close back. The cleistogamous flowers are so numerous in comparison with the others that it is rarely that one meets with an open flower in a morning.

A result of the almost general self-pollination amongst the smaller millets, as indicated above, is the remarkable uniformity of the crop. A field study of these crops reveals but few varieties. The greater millets, in which crossing is considerable, on the other hand, show many varieties. The varietal characters amongst the smaller millets are often such insignificant ones as stigma colour, variation in the size of grain, and branching habit.

FURNACES FOR THE MANUFACTURE OF *GUR*.

BY

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As a sugarcane producing province, the Punjab ranks second in importance in India. The area annually under this crop varies between 4½ and 5 lakhs of acres. This represents some 18 per cent. of the total area under sugarcane in British India. It is generally considered to be one of the best paying crops which the average cultivator grows, and with him its area is limited mainly by the lack of sufficient irrigation water for a larger area. This at least holds good for canal and well irrigated lands. So far as its water requirements are concerned, it makes greater demands than any other crop, requiring during its growth some 12 to 15 irrigations (in a district where the annual rainfall is 13 inches) as against four for wheat and five or six for cotton.

In the canal colonies of the Punjab, the average cultivator puts one acre per square, or about 4 per cent. of his land, under sugarcane. From this area he eventually gets about 30 maunds (1 maund = 82 lb.) of *gur* (crude, unrefined sugar) which is the form in which he usually disposes of this crop. This quantity is the produce after evaporation of about 170 maunds of juice. The trials later described show that to evaporate 100 maunds of juice he ordinarily requires from 70 to 80 maunds of fuel. Hence, for the juice from one acre of cane fuel to the extent of some 120 to 130 maunds is required. Recently in experiments conducted at Lyallpur with better varieties of cane which contain a higher percentage of juice,

yields of 80 to 90 maunds of *gur* are being obtained. These varieties are just beginning to be taken up by the zemindar. The fuel which he will require will thus be proportionately greater than he at present needs with his local canes. These higher yielding canes cannot, indeed, produce sufficient fuel for the evaporation of their own juice.

One of the greatest problems in most parts of the province is the supply of fuel. Failing anything else, the zemindar always falls back on that most destructive and uneconomic of all sources, viz., his farmyard manure. Unfortunately most of this is still consumed as fuel instead of being returned annually to the land from which it comes. In the case of the fuel necessary for *gur* making, the cane crop itself provides most of what is required in the form of leaves and the megasse obtained after extracting the juice. With the ordinary country method of *gur* making all this is required for the evaporation of the juice, and in some cases other materials such as cotton sticks have also to be used.

The destruction as fuel of the large mass of foliage provided by the crop is highly uneconomic, as these leaves contain a large part of the plant food which the crop has removed from the soil. They are valuable as a manure, and if furnaces can be introduced which will reduce the amount of fuel required for the evaporation of the juice, the leaves that can be spared are at once rendered available as manure. Fuel and manure are very closely correlated in this country, and in the present case the cane foliage is released either to be used as litter for the farm stock, and so find its way eventually to the manure heap, or to be ploughed in directly to the land. Any saving in fuel of this nature, therefore, which can be effected releases a similar amount of material for manure. These leaves are especially good not only on account of the food material they contain but for the humus which they add to the soil, thereby increasing its water holding capacity—a point of very practical importance here.

In the improvement of furnaces the saving of time is another point to be aimed at. Normally the zemindar is dependent entirely on the sun to dry his megasse and make it fit for burning, and when

the elements fail him, as they often did here during the past season owing to dull weather and occasional rain, he has no alternative but cease work till the sun shines again. This runs his harvesting very late in the season, and he is still crushing cane when he should be preparing to sow cotton, or harvesting his *rabi* crops. A furnace, therefore, which will be more economical in time as well as in fuel is what is aimed at.

The investigations made here this year on the improvement of *gur* furnaces were originally necessitated through the purchase of a large power driven cane crusher. The small country furnace in use was not sufficient to deal with the quantity of juice produced. After some trials with a large furnace of the McGlashan type, in which its efficiency was compared with the local furnace, we then passed on to the investigation of smaller types more suited to the small growers of this district. In all cases, whether with large or small furnaces, the object aimed at was to produce a furnace which would save both fuel and time and whose installation would entail a minimum expense to the zemindar.

The following are the various furnaces tried :—

I. The local furnace.

This consists of a large circular pit six feet deep with slightly curved sides. The feeding mouth is a circular hole 12 inches in diameter situated some 6 inches below the top of the furnace. The exit for the smoke and hot air is placed opposite the feeding mouth and is a circular hole 10 inches in diameter. After passing through a flue the smoke emerges from a chimney 6 to 7 feet high. The top of the furnace is a circular opening about 2 feet 10 inches in diameter on which an iron pan, with curved bottom and sides, is placed. This pan can hold from 1½ to 2 maunds of juice at one time.

This furnace is the one in most common use all over the province, and is the most primitive and the most inefficient of all the furnaces tried. It suffers from three great defects :—

(*a*) The fuel as it is fed falls in a heap on the bottom of the furnace, part of it becoming buried in the ashes.

The supply of air is limited and very imperfect combustion is obtained. This is clearly shown by the large amount of ash remaining behind and by the fact that one often finds the furnace still smouldering for days after work has ceased.

(*b*) The pit is very deep, and the flame is too far from the bottom of the pan.

(*c*) The flame is directed towards the hole for the exit of smoke and so does not give the maximum heat to the pan. Much of the heat is, in fact, lost for this reason.

A scale diagram of this furnace is given in Fig. 1 and the figures showing time taken and fuel consumed are given in Table I.

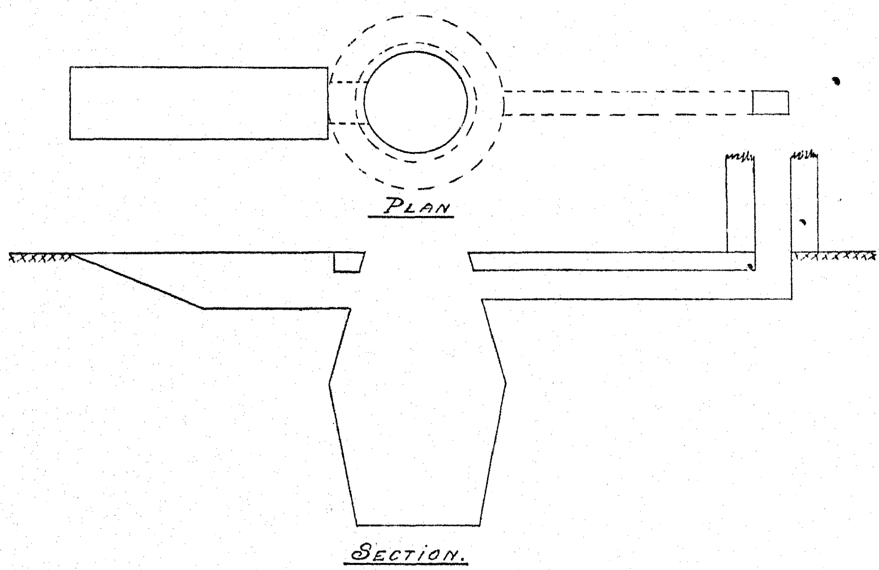

FIG. 1.

(All figures are on the scale of $\frac{3}{16}$ inch = 1 foot.)

From the latter it is seen that the time taken to evaporate one maund of juice is 46·4 minutes and the fuel necessary for this is 70 per cent. of the weight of the juice.

TABLE I.

Country furnace.

Juice evaporated		Fuel consumed		Time taken		Time taken to evaporate 1 maund of juice	Fuel used per 100 maunds of juice
Mds.	Srs.	Mds.	Srs.	Hrs.	Mins.	Mins.	Mds.
3	6	2	20	2	38	50	79·3
1	23	1	2	1	15	48	66·6
4	29	3	30	3	21	42	78·9
4	25	3	27	4	30	58	79·6
9	27	6	11	6	2	38	64·8
15	30	10	16	11	0	42	66·0
				AVERAGE ..		46·4	70·0

II. THE McGLASHAN FURNACE.

This furnace is described in the *Agricultural Journal of India* (Vol. XV, 1920, p. 520) and *Bulletin No. VIII of the Department of Agriculture, Central Provinces.* It was set up at Lyallpur in its

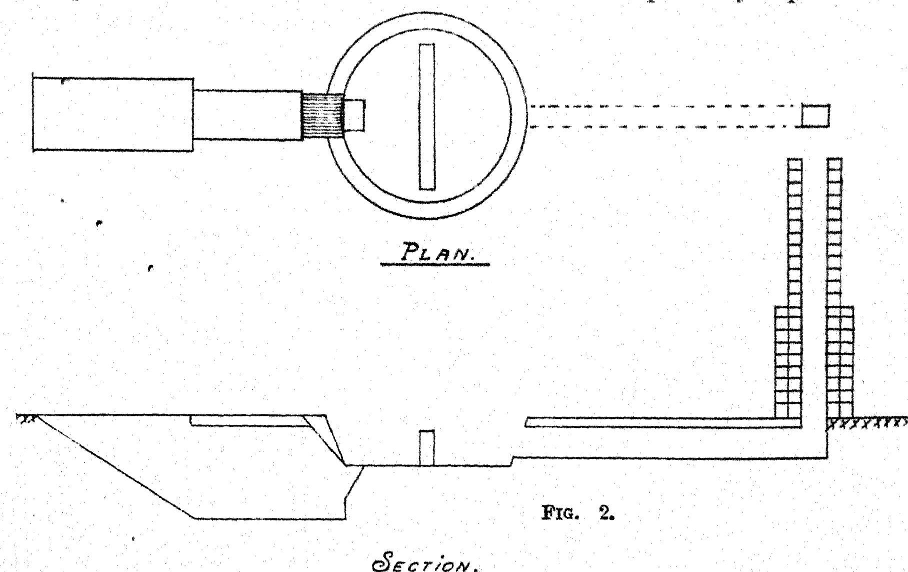

FIG. 2.

original size and according to the dimensions given in the Bulletin above quoted. From the figures given in Table II it will be seen that in comparison with the old country one it is a most efficient furnace. The average time taken to evaporate one maund of juice was 18·9 minutes and the fuel consumed is 33 per cent. of the weight of juice. This represents less than one-half the fuel and considerably less than half the time required for the country furnace.

TABLE II.

McGlashan 7-feet furnace.

Juice evaporated		Fuel consumed		Time taken		Time taken to evaporate 1 maund of juice	Fuel used per 100 maunds of juice
Mds.	Srs.	Mds.	Srs.	Hrs.	Mins.	Mins.	Mds.
6	23	2	23	1	55	17	34·1
6	33	2	3	2	0	18	30·4
6	33	2	10	2	0	18	32·9
6	33	2	15	2	20	20	34·8
6	37	2	19	2	8	18	35·7
11	22	4	0	3	0	16	34·6
8	16	2	30	2	15	16	32·7
8	16	2	32	2	30	18	33·3
29	16	9	25	..	..	..	32·7
10	32	3	30	4	35	25	33·6
5	16	1	24	..	..	..	29·7
16	8	4	29	5	25	20	29·2
				AVERAGE ..		18·9	33·0

This is the most efficient furnace of those so far tried. It is a very good furnace for the zemindar who grows a large area of cane and will save him much in time and fuel. Two such furnaces can deal with the juice from a power driven cane mill crushing 14 maunds of cane per hour, or one furnace can evaporate that produced by two of the bullock driven iron mills in common use in most districts in this province. For the average cultivator here, however, something smaller would be more practical, as his area under sugarcane is generally not more than three acres.

It is noticed here that when canes are crushed with a power machine the megasse is broken into small pieces which are inclined to fall through the grating during feeding to the furnace if the grating is made to the specification given in the Bulletin quoted. This was remedied here by using $\frac{1}{4}$ inch bars instead of $\frac{1}{2}$ inch bars and placed $\frac{1}{8}$ inch apart instead of $\frac{1}{4}$ inch. This was a decided improvement and all the gratings afterwards used were of these dimensions.

III. MODIFIED MCGLASHAN FURNACE WITH $4\frac{1}{2}$ FEET PAN.

In order to provide the small cultivator with a furnace more suited in size to his requirements than the 7-feet McGlashan and at

the same time give him the advantages of the improvements therein obtained, a furnace was constructed of the McGlashan type but reduced to accommodate a $4\frac{1}{2}$-feet pan. It soon became apparent that this furnace was not completely successful. Its main defects were that the juice boiled only near the feeding mouth and not equally all over, that the heat near the mouth was so great that the juice became burnt and that the consumption of fuel was not very much less than with the country furnace. These faults were remedied after further investigation in two ways : (1) by setting the brick and mud wall which was in the centre of the furnace floor farther back nearer the smoke exit, and (2) by reducing the exit flue from 15 inches × 7 inches to 9 inches × 7 inches. Whereas in the full scale McGlashan the distance from the grating to the centre wall was 3 feet 3 inches, in the reduced size it was only 2 feet. The flame had therefore a very short distance to travel till it was deflected upwards to the pan and accordingly was so strong that the juice was burnt. Further, the back flue was so close to the feeding mouth (only 4 feet) that much of the heat passed directly out without aiding in evaporating the juice. The lay-out of this furnace is given in Fig. 3 and the results obtained in Table III. They show that the fuel consumed is higher than

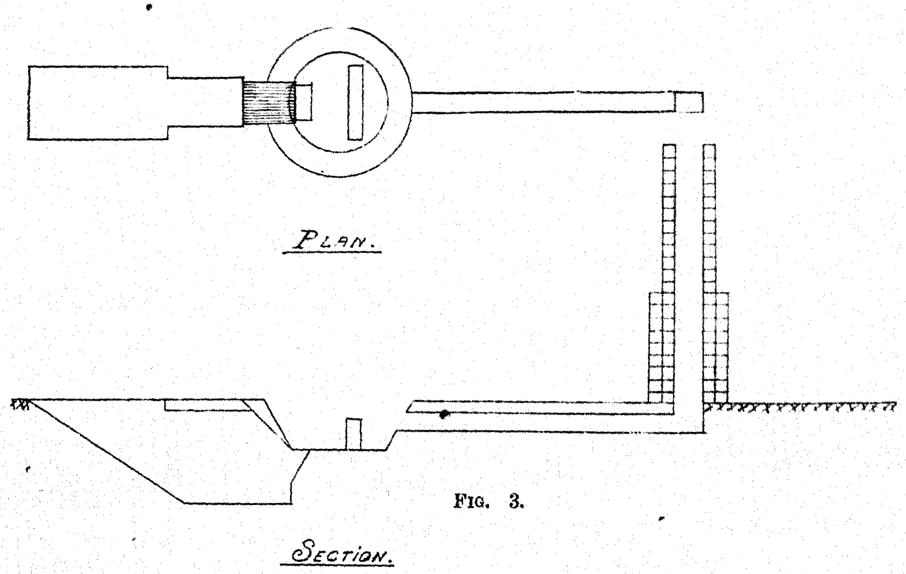

FIG. 3.

in the full size McGlashan but is only two-thirds of that of the country furnace. The time saved is over 20 per cent.

TABLE III.

Improved McGlashan $4\frac{1}{2}$-feet furnace.

Juice evaporated		Fuel consumed		Time taken		Time taken to evaporate 1 maund of juice	Fuel used per 100 maunds of juice
Mds.	Srs.	Mds.	Srs.	Hrs.	Mins.	Mins.	Mds.
7	35	3	25	5	0	38	46
7	35	3	24	4	30	34	45
8	16	3	37	5	0	36	46
10	20	4	33	6	0	34	45
5	10	2	12	2	45	32	42
8	37	3	30	3	30	24	41
7	35	3	25	5	0	38	46
7	22	3	16	4	7	33	45
7	35	3	24	4	58	38	46
5	31	2	24	3	43	38	45
5	10	2	12	3	55	45	44
				AVERAGE ..		35·5	45·6

IV. MULTIPLE FURNACE.

In this experiment an attempt is made to make use of the waste heat which passes out through the flue of the reduced McGlashan by causing it to pass under a second pan and so evaporate a further quantity of juice. Fig. 4 shows the

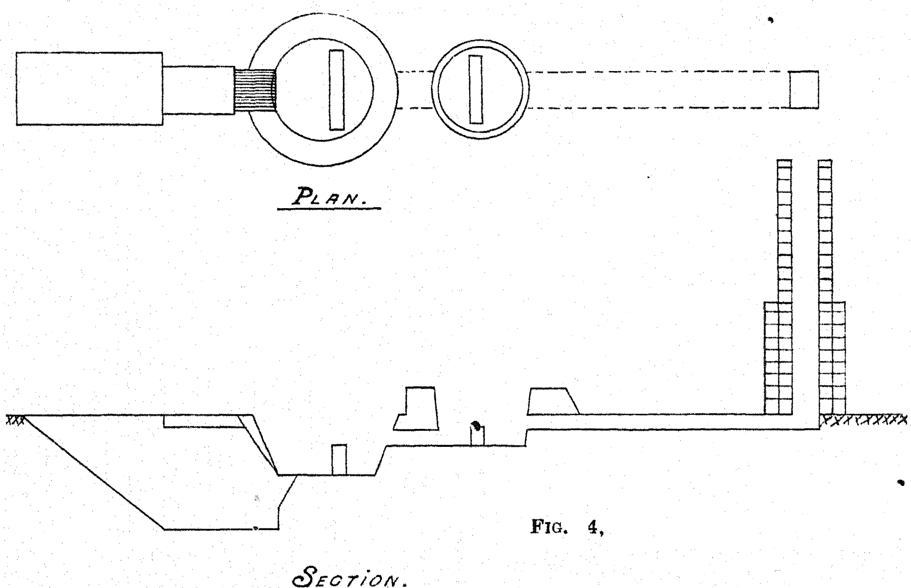

FIG. 4,

arrangement of this furnace. The first part is exactly as described for the reduced McGlashan. The second pan is placed at a level 15 inches higher than that of the first pan. Whereas the latter is 4½ feet in diameter, the second is 3 feet and the furnace for it is 2 feet 7 inches in diameter at the top. About 2 to 2½ maunds of juice are put in the first pan and about half a maund in the second. Whilst the juice in the first has become partially evaporated, that in the second has become hot and somewhat less in volume. Later the juice from the second is run into the first where evaporation is completed, fresh juice being added to the second. The results obtained appear in Table IV and show a very great saving in fuel over the country furnace. In point of economy of fuel this furnace comes next to the full size McGlashan, using only 40 per cent. of the weight of juice evaporated. The reduction in time though considerable is not yet what it should be and falls far short of the large furnace.

TABLE IV.

Multiple furnace, improved McGlashan type.

Juice evaporated		Fuel consumed		Time taken		Time taken to evaporate 1 maund of juice	Fuel used per 100 maunds of juice
Mds.	Srs.	Mds.	Srs.	Hrs.	Mins.	Mins.	Mds.
5	29	2	22	3	45	40	44
3	38	1	26	2	24	37	40
5	10	2	6	2	45	31	41
8	37	4	17	5	20	36	49
12	3	5	12	6	55	34	44
9	18	3	26	..	..	..	39
7	0	2	28	5	0	43	39
15	30	6	15	..	..	..	41
9	18	3	32	5	25	35	40
9	18	3	35	5	30	35	39
15	30	6	20	..	..	..	41
13	30	4	30	..	..	..	35
6	12	2	12	4	20	41	36
18	36	6	30	..	..	..	36
				AVERAGE	..	36·4	40

V. The improved local furnace.

In this an attempt has been made to improve the ordinary country furnace so that the zemindar could still use his ordinary curved bottomed pan. In all the other experiments described the pans used have all had flat bottoms. All the important points of the other furnaces were embodied in this furnace, viz., grating, flue, bottom wall, etc. In this case it was found that two walls on the floor of the furnace were better than one. The great depth of the country furnace was also reduced. Fig. 5 shows the arrangement of this furnace.

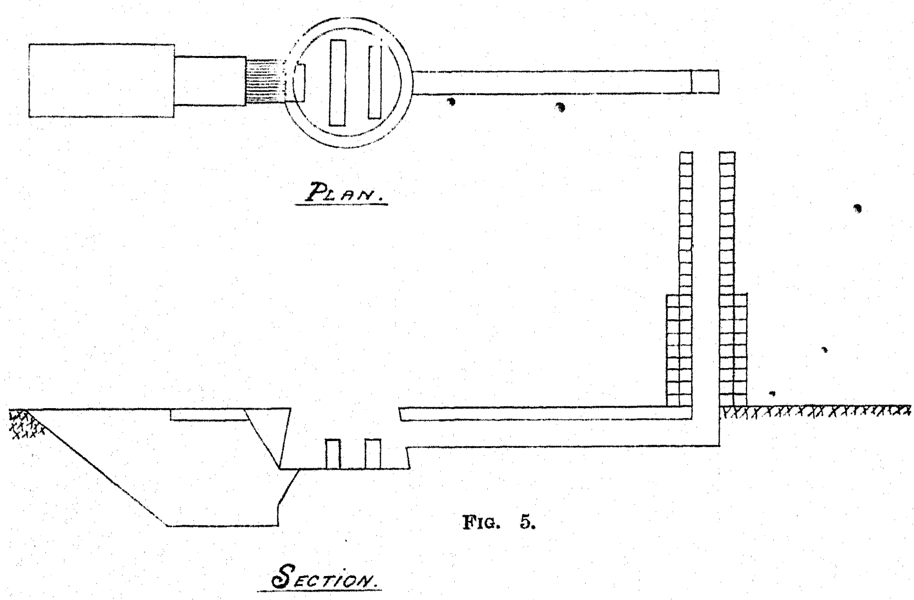

Fig. 5.

From Table V it will be seen that there is a saving of about 25 per cent. in the fuel consumption as compared with the old country furnace but no saving in time so far as the experiment has at present been carried.

No tests were made with the idea of comparing flat and round bottomed pans, but it would appear that the flat pan is much the more efficient. It is recommended, therefore, that, as soon as the old round bottomed pans become unserviceable, flat pans could be

TABLE V.

Improved country furnace.

Juice evaporated		Fuel consumed		Time taken		Time taken to evaporate 1 maund of juice	Fuel used per 100 maunds of juice
Mds.	Srs.	Mds.	Srs.	Hrs.	Mins.	Mins.	Mds.
3	6	1	35	3	0	58	59
5	20	2	32	5	0	55	50
6	12	3	20	5	0	48	55
2	25	1	12	1	5	25	49
6	12	3	20	5	10	49	55
6	12	3	19	4	36	44	55
8	2	4	7	6	36	49	52
6	4	3	30	5	50	57	61
4	3	2	16	3	45	55	59
3	22	1	37	3	35	61	54
8	16	3	34	8	12	58	46
23	4	11	20	18	30	48	50
				AVERAGE ..		50·5	52·7

substituted with no additional cost and with the gain of much fuel. Meantime, whilst these pans continue to be used, the zemindar can effect some saving in fuel by altering the type of his furnace at little or no cost. The grating costs about Rs. 2, and the whole of the work he can do himself with very slight cost.

Where a cultivator has up to eight acres of sugarcane, he usually has one bullock driven crusher and two country furnaces. The work of these two furnaces can easily be done by one multiple furnace of the type described above. He can thus save a very large amount of fuel and, in addition, less labour will be required. For ten acres of cane two bullock crushers or a power driven machine are required. For dealing with the juice from these, three country furnaces are required. These can be replaced by one furnace of the full size McGlashan type, resulting in the saving of an enormous amount of fuel as well as of time and labour. The cost of erecting a McGlashan furnace is less than that of three country ones. The 7-feet pan weighs about 4½ maunds and costs about Rs. 90, while three country pans amount to about the same. The cost of making the furnace itself is not more than Rs. 5.

The following are the comparative figures for the various furnaces tried :—

Type of furnace	Average time required to evaporate 1 maund of juice	Average fuel required to evaporate 100 maunds of juice
	Mins.	Mds.
Country furnace	46·4	70·0
McGlashan, 7 feet	18·9	33·0
Improved McGlashan, 4½ feet	35·5	45·6
Multiple furnace	36·4	40·0
Improved country furnace	50·5	52·7

It is thus seen that all the types tried above are better than the local furnace. Of them all, the full-sized McGlashan is the best and is suitable for large cultivators or for small zemindars also if two or three co-operate together and use their bullock driven cane crushing machines jointly for such a furnace. Should he not wish to discard his round bottomed pan, the zemindar can at a trifling cost alter his furnace and save much fuel, until such time as he requires a new pan when he should purchase a flat bottomed one. The saving effected will then be much greater as the megasse is practically sufficient to evaporate the juice, rendering almost the whole of the trash and leaves available as manure.

The practical work embodied herein has been carried out entirely by the second author with suggestions from the first named who is responsible for its presentation.

THE MESQUITE (*PROSOPIS JULIFLORA*).

BY

W. ROBERTSON BROWN,

Agricultural Officer, N. W. Frontier Province.

In the March (1923) Number of the Journal (XVIII, Pt. 2), Dr. K. Kunhikannan brought this useful sub-tree to the notice of the Indian farmer. My first acquaintance with it was in 1905 at Lahore, where its remarkable resistance to drought was already fully appreciated by the Superintendent of the Agri-horticultural Gardens, and it was being successfully employed to clothe red sun-baked brick-kiln mounds in the gardens and around the city. Since then I have seen the mesquite at many places between Cawnpore and the Khyber, also in South Africa, and no matter how hot the position, the tree has invariably been vigorous and bountiful of fruit. At the Peshawar Agricultural Station, where the mercury frequently exceeds 120° F. in the burning summer days, and falls to 26° F. in the cold season, where the average annual rainfall is about 13 inches only, a trial was started in 1911 to determine the economic value of the tree, as food for stock, for fuel, and in clothing dry waste land. With no attention whatever since the plants were set out, the mesquite has flourished exceedingly and borne heavy crops of beans (Plates XXI and XXII, fig. 1). The results of the observations at the station may be briefly stated as follows:—

Food for stock. Well-fed sheep and goats readily eat the ripe beans under the trees, but take them sparingly from the crib. Cattle or horses in good condition do not eat the beans. Neither sheep, goats, cattle, horses, nor even camels willingly eat the mesquite leaves.

Fuel. No tree grows more rapidly than the mesquite on arid land, or yields more fuel thereon in a shorter space of time. The wood burns well.

Fig. 1. A spray of mesquite beans.

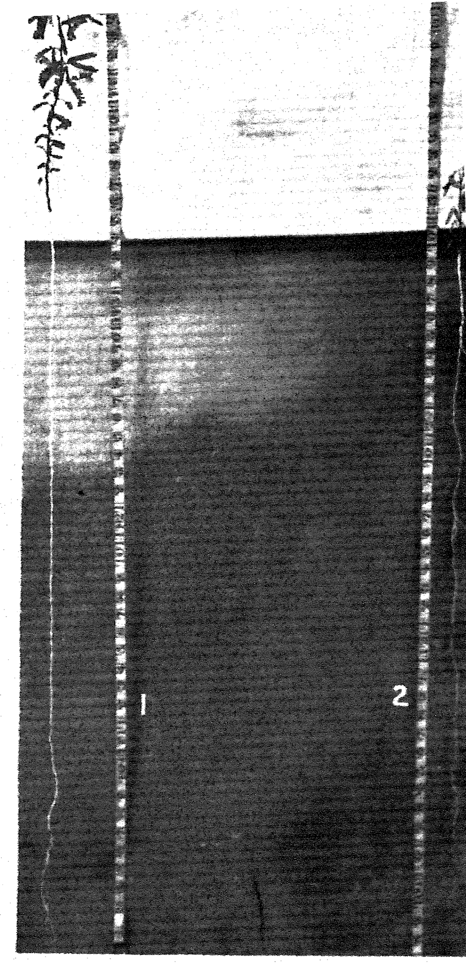

Fig. 2. Mesquite seedlings:
(1) three months old; (2) one

Clothing arid land. To convert bare, drought-stricken yet fertile land in the N. W. F. Province into open wood-land, it is only necessary to establish a few groups of mesquite trees on the tract, and to leave the work of seed distribution to the sheep and goats which eat the beans but not the plants. To clothe dry sun-stricken ravine land, or to embellish slopes or banks, no shrub or plant of any kind known to me can compare with the mesquite in persistent vigour and delicate beauty. From the beginning of April, when the pendulous sprays of graceful feathery foliage and honey-coloured tassels of blossom unfold, until late November when, for the second time in the year, the branches of the trees bend with their load of nourishing beans, few of the great family of Acacias are more pleasing than the mesquite. By the roadsides in desert tracts, where the *kikar* (*Acacia arabica*), the *ber* (*Zizyphus jujuba*), the *phulai* (*Acacia modesta*), and even the *Jhand* (*Prosopis spicigera*) do not survive, the mesquite can be established in belts or plantations (Plate XXI). In the past few years, officers who have been studying at the Peshawar station with a view to farming abroad, have been impressed by the beauty and usefulness of the mesquite, and numerous parcels of seed have been sent to them in Africa and Australia.

When on an agricultural tour in South Africa in 1921, I was invited to visit some farms on the Karroo—that vast dry tract of heathery scrub whereon, in the frequent visitations of drought, hundreds of thousands of the Merino lambs have to be sacrificed at birth to save the famished ewes from death —and to think of any drought-resistant shrub or tree which might help to tide over the periods of pasture famine. As the homestead of the first Karroo farm was approached, almost the first trees to come in my view were mesquites. An eager inquiry revealed the fact that the trees had been planted by an officer of the Indian Irrigation Service who had been engaged in the construction of a dam near the farm, and had procured the seeds from the Punjab. I was informed that the sheep ate the beans greedily, and that by their agency seedlings were springing up far over the land. The farm manager only feared that the mesquite might become too aggressive. I determined

to find by actual experiment in India the extent to which seedling mesquites might be expected to germinate from the dung of sheep not specially fed on mesquite beans, but which had picked up the beans in the course of their daily wandering over stubble, on pasture, or under the mesquite trees. On 6th September, 1921, 10 seed-beds, each measuring 8 square yards, were sown with the dung of the Peshawar station sheep which have access to mesquite trees. The dung was over six months old, and it is noteworthy that it had not been consolidated. It is the practice at the Peshawar station to sweep the pens and remove the droppings almost daily. The beds were irrigated and within five days fully 300 mesquite seedlings sprang up in each small bed. When the plants were 4 inches high and less than a month old, the roots of some of them were found to be over 4 feet long (Plate XXII, fig. 2). To gain information on a field scale, a border, half a mile long and 12 feet wide, was next manured with the sheep dung. Seven days after irrigation was given—within seven days of spreading the dung—thousands of seedlings germinated throughout the length of the border. The results of these tests were published in the *South African Journal of Agriculture* (January 1923). Clearly then, sheep eat mesquite beans and the voided seeds germinate readily when the land is moist. To establish the mesquite on any dry tract or ravine land between Cawnpore and Peshawar, it is only necessary to sow small nucleus areas here and there, after rain has fallen in the month of August or September, or perhaps even in the early spring, and to let the plants fight their way to fruitfulness, after which the sheep and goats may be depended on to clothe the land with this valuable famine fodder. Although the germination of the seeds is most surely attained by feeding the beans to sheep, excellent results may also be got by pouring boiling water over the seeds in the evening and letting them steep till they are sown on the following day. Beans or seeds of the mesquite can probably be supplied by the Government gardens in North-West India. The crop at Peshawar is being employed in sowing bare ravine land in the province.

THE CULTIVATION OF POTATO IN ITALY.*

BY

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Amongst the important potato growing countries of Europe, Italy occupies the seventh place with 300,000 hectares (1 hectare =2·47 acres) devoted to the crop, against 2,647,161 in Germany which stands first, 1,453,310 in France which stands third and 517,873 in Great Britain and Ireland which stands fifth.[1] Though it stands so low in acreage, Italy has certain natural advantages over other countries. As it is situated far enough south to secure the benefit of brilliant sunshine and comparative freedom from spring frost, the potato harvest begins much earlier. The early crop begins to ripen from May, the main crop is ready from July onwards and the hill crops are lifted in September-October. As most of her crop is dug before the general harvest of Europe begins, Italy retains to a certain extent the monopoly of supplying, in the earlier part of season, the markets of Austria, Hungary and Germany and at times those of France, England and Belgium. Her main crop, however, is exported to Constantinople, Smyrna, Egypt, Aden, Bombay and Colombo.

As the potato cultivation in the Bombay Deccan and to some extent in Madras and Mysore is dependent on the importation of Italian seed tubers, and as no information, as to how these seed tubers are grown in Italy, was available, the writer spent a short period of his deputation in the month of August 1922 to study this

* This paper, based on observations made by the writer while on deputation to Europe to study the potato crop and its diseases, was read at the Indian Science Congress, 1923.

[1] *Inter. Yearbook of Agri. Statistics*, 1909–1921.

industry in Italy. A short description of the potato cultivation in Italy[1] should, therefore, be of interest.

Excluding the driest tracts, the potato is cultivated everywhere in Italy. The districts that interest India most, however, are Naples, Caserta, Salerno, Avellino, Benevento, Campobasso and Aquila. All the places except the last two are near Naples comprising the province of Campania. Campobasso is on the border of Campania, while Aquila is situated north-east of Rome in the Appenine Hills.

The province Campania, meaning "The Plain," has a densely crowded population and intensive cultivation. It is one of the most prosperous and fertile tracts, enriched by the ashes of Vesuvius, and has therefore become a great seat of Italian commerce centring in the seaport Naples.

A great peculiarity of this tract is the growth of vines round elm trees planted in rows between which other crops are grown. The potato, therefore, forms one of the secondary crops in the grape gardens. This mode of cultivation naturally demands a very rich soil and is practised also in the basin of the river Po and in Sicily. The soil is very fertile and easy to work, as it is a deep good loam. The climate is quite suited to the crop. The mean temperature is 60° F., and the average rainfall is 32 inches and is well distributed. Therefore no irrigation is practised. It is only in the immediate vicinity of the towns where cultivation is very intensive that irrigation is sometimes resorted to whenever the rains fail. Water is raised from shallow wells of 5 to 10 feet deep by the lift *noria* worked by a single animal, either a mule, ass or horse. At some places a *pikota*-like handlift is used.

The crop is grown in small plots. The average size of holdings is five to ten acres, though fields of fifteen acres and upwards are not uncommon. Usually half the area of the holding is under potato. The cultivator rents the land from the landowner.

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[1] The writer begs to acknowledge his indebtedness to the officers of the British Embassy at Rome, to those of the Italian Department of Agriculture, to those of the International Institute of Agriculture, Rome, and to Mr. Little, a potato merchant at Naples, for the help rendered by them in getting information on the subject.

The cultivation is carried on by hand labour with an implement called Zapa. In the months of August and September the land is dug with the Zapa, and the green manuring crop, either lupin, bean or turnip, sometimes all the three mixed together, is broadcasted. It is buried, for the early crop, in December, and for the late one in January or February. Soon after this operation the potato crop is planted. The sets are put at forty centimetres apart in furrows of sixty centimetres distance. The seed rate per acre is about eight quintals (1,760 lb.).* After germination, when the shoots are two inches high, the crop is top-dressed with either sulphate of ammonia or superphosphate (150 lb. per acre). When the plants attain a height of about six inches, that is to say, in the month of April, they are earthed up and sprayed with Bordeaux mixture as a preventive against blight (*Phytophthora*). The crop then requires little attention during its growth period. An occasional hand-weeding or a second spraying, if the weather conditions get moist, are the only operations. The early crop is ready in May and the late one matures from July onwards. The crop is harvested by hand-digging and the tubers are sorted into three grades: big, medium and small. The big ones are for immediate sale, the mediums are reserved for seed and the small ones are used for pig-feeding. The average yield per acre is 50–60 quintals. In good fields it rises from 80 to 100 quintals, and in the best fields even 120 quintals have been recorded.

The seed tubers are stored in sheds called Peglia situated near the farm-houses. They are usually made of lupin straw and are ten feet long, six feet wide and eight feet high. The tubers are at times stored in pits called Fossi dug in the fields. The pit is lined with straw before the tubers are put in. The upper part of the heap is also covered with straw and earth. Peglia is preferred to Fossi as it affords tubers better protection against cold and rain in winter and prevents the various kinds of rots due to defective ventilation and heating obtained in the Fossi system. The tubers stored in Peglia usually remain in good condition till the

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* A quintal is equal to two cwt. roughly.

planting time. In Italy the storage of potatoes for seed is not a problem as it is in India. The amount of rotting of tubers caused by fungi (*Fusarium*, *Sclerotium*) and bacteria is very little owing to the cool climate and the good ventilation of the storehouses. The mean temperature in July, when the potato harvest begins, is not above 75° F., and from November onwards, when the tubers are put in the storehouses, the temperature falls considerably. It is in warm years that damage is sometimes caused to the tubers by the rots. In August 1922, when the writer was in Italy, it was exceptionally warm at Rome and Naples. The maximum temperature was above 90° F. for some days, and therefore he could notice the *Fusarium* and bacterial rots in the fields as well as in the stores. But the rots, he was told, stop as soon as weather becomes normal.

Rotation. Near Naples the crop is rotated with wheat in the first year, maize or hemp (*Cannabis sativa*) in the second year, potato following again in the third year. At other places wheat follows potato, then comes clover in the second year, wheat, maize or hemp in the third year and then potato in the fourth year.

Varieties. (1) The potato known in Bombay as Italian white round is the one grown very widely and is called Riccio. It is a hardy, high yielding variety withstanding rough handling to a considerable extent and is of two types. One of these has white flesh; the other has yellow flesh. The latter is more commonly grown and is said to be a little bit later than the former. (2) A second variety consists of long white tubers and is called Nostrale. It is said to be less susceptible to blight (*Phytophthora*). (3) The third is called Patata Rose. It consists of pebble-like tubers with a reddish skin and eyes. (4) And lastly, there is a very early variety maturing in three to four months, which is called Matilde. Riccio is exported in bags and the remaining three varieties, being delicate, are packed in chestnut wood boxes.

Diseases. It is interesting to find that the potato crop in Italy is practically free from the fungus and insect diseases, particularly from those that come under the Destructive Insects and Pests Act. The belief that the potato moth (*Phthorimea operculella*) must have been introduced into India along with the Italian potato, therefore,

would seem doubtful. The writer was told by Professor Sylvestri, the Entomologist and the Director of Agricultural Institute, Portici, Naples, that the moth has never been recorded in Italy though it occurs in the Malta Islands and Egypt. The moth reached Sicily only once with a consignment of tomato plants from Egypt, when it was immediately destroyed, and since then the solanaceous crops have been listed under the Pests Act. The only disease that is sometimes destructive to the potato crop is blight (*Phytophthora*), for which the crop is regularly sprayed. The following diseases have, however, been recorded, but no special study of these has been made since they do not do any damage to the crop :—

Ring (*Bacillus solanacearum*),
Fusarium,
Eelworms.

None of the destructive diseases that are prevalent in other countries of Europe, viz., wart (*Synchytrium endobioticum*), mosaic, and leaf-roll are said to occur in Italy. One fact, however, that attracted the writer's attention was that the cultivator replenishes his seed from the hill tract whenever the crop degenerates. The recent study of the subject of degeneration has shown that degeneration is but a symptom of a disease and this disease is probably mosaic.[1] It is, therefore, probable that a more thorough study of the degeneration question in Italy might reveal the existence of mosaic disease which is now supposed to be non-existent.

Resuming this short account of the potato cultivation in Italy and contrasting it with that in the Bombay Deccan, the following points arrest attention :—

Italy	*Bombay Deccan*
Potato is a rain crop.	It is an irrigated crop, at least in *rabi* season.
It requires 5 to 6 months to mature.	It ripens in 3½ months.
It is practically free from fungus and insect diseases. Moth and wart have never been recorded. Ring has not been known to do any damage.	The crop is much damaged by moth, ring and *Fusarium* diseases.
Storage of tubers is not an important problem and therefore the cultivator preserves his own seed. It is only when the crop degenerates that he gets the seed from the hills.	Storage is extremely difficult, as there is a considerable amount of rotting of tubers. The cultivator therefore has hitherto been unable to preserve his seed and is dependent on the Italian tubers.
Average yield is 6 to 7½ times the seed rate.	It is the same here too.

[1] Salaman. Degeneration of Potatoes. *Rep. Internat. Potato Conference of* 1921, pp. 79–91.

CATTLE BREEDING.*

BY

WILLIAM SMITH.

Imperial Dairy Expert.

I AM aware that the Committee now sitting in Poona is one mainly concerned with cattle breeding as it specially affects the Presidency of Bombay, but I am sure the Committee will not object to my dealing with the matter from an all-India point of view and on general lines.

I think it is well in dealing with a subject like this to endeavour as far as possible to state—

(1) The present condition of the industry,

(2) Causes of existing conditions, and

(3) Steps to be taken to improve existing conditions.

As regard (1), I have now been in India for sixteen and a half years during the whole of which time I have been in very close touch with the cattle breeding industry in the Punjab, the United Provinces, Central Provinces, Sind, Bombay and Madras, and it is my considered opinion that in these parts of the country the quality of the cattle has declined since I came to India, or to put it more definitely, I believe that, generally speaking, it is impossible in the open market to-day to procure in quantity, no matter what the price may be, as good draught bullocks and milch cows as were obtainable 16 years ago. Most certainly the quality of milch cattle available in India, except in the district of Sind, is very much worse than those available 16 years ago. If that be so, it behoves us to look for the reason for such a decline at a time that practically every other country in the world has been able to improve the quality of its cattle, and the root reason undoubtedly is want of

* Note submitted to the Bombay Cattle Committee, 1922.

knowledge, accentuated by many circumstances such as the spread of irrigation canals and conservation of forest lands with consequent diminution of grazing areas, the increased facilities for transport and consequent mixing of breeds or types, increased prices for human foodstuffs, and the deliberate and erroneous teaching by the departments responsible for cattle breeding that the development of dairying or milk production would injure the draught quality of working bullocks. I look upon it that the wilful elimination of milking qualities in the stud bulls issued by Government for breeding purposes and the persistent teaching of all concerned in cattle breeding for many years in India that dairying or heavy milking qualities of dams are injurious to the qualities of plough cattle have probably done more harm to cattle breeding in India than any thing, because this elimination of milk-giving qualities strikes at the root of the whole industry. So little attempt has been made to develop milking quality of most breeds of Indian cows that the dams even of some of the finest breeds of cattle are unable to suckle their young within a reasonable time, which means later maturity and fewer calves during the lifetime of the dam.

In time past this did not matter so much, as great breeding areas were available which were useless for any other purpose, but these areas now grow cotton, or pulse, or wheat, and what must take their place. The ordinary cultivator must take their place, and to enable him to do this profitably he must have a cow which will give sufficient milk and *ghi* (clarified butter) for his family and at the same time rear a good draught bullock. As things are now, the cultivator in India keeps one or two or three cows which can hardly produce enough milk for their calves, and he keeps a female buffalo to give milk and *ghi* for his family. This female buffalo is quite unnecessary if the breeder can get a cow which will rear the calf and in addition provide the breeder with milk and *ghi*. Nothing is more certain than that the dam of any type or class of good working bullock whatever can and ought to be a first class milker. We hear many people say that the solution of the cattle breeding problem is to grow more fodder but that is putting the cart before the horse. What we want is fewer but more efficient cattle. No

country in the world can afford to keep a cow which is only capable of suckling a calf. The enormous increase in the number of buffaloes in India is the cause of the fodder shortage, because not only is the female buffalo used because the cow is such an inefficient milker, but the male buffalo is often permitted to survive. This male is useless for draught in most parts of the country, and between the female buffalo used because the cow is not as good a milker as she might be and the useless male buffalo the country is drained of its fodder to such an extent that there is not sufficient for any class of cattle.

The solution of the whole matter lies in the dual purpose animal. No matter what class or type of male plough bullock is required, the dam must always be a good milker, and all bulls issued for stud purposes must be got from heavy milkers as well as be of the right size, type and class.

This country can produce all the draught cattle it needs, more than all the dairy produce it can consume from much fewer cattle than we now possess, but they must be more efficient cattle and they must be *dual purpose* every time. Any propaganda outside of *dual purpose* efficiency is only perpetuating a great economic evil. No other basis can be profitable.

If these are the reasons for the present state of affairs, then the first steps to remedy matters is dairy education. In every civilized country in the world to-day dairying occupies a very prominent position in its Agricultural Department. There is not, at the present moment, a single dairy school in India. The crying need of this country agriculturally is dairy education, both of the cultivator and the masses. Not only is the education of the men in the street necessary from the cattle breeding point of view, but it is necessary from the point of the health and general well-being of the people. The milk supply of our cities is probably the worst and most expensive in the whole world, which fact in itself is a proof of the crying need of the dual purpose cow. We do not need beef and the country does not want it, but milk and draught we must have and it is indisputable that these qualities can and must be combined in the cow of the future.

In this note I, of course, have not touched details of any kind but have confined myself to basic policy, because and until we have our policy based on sure economic foundation we can do nothing. The only practical and sound cattle breeding policy is dairying plus draught qualities; the one is hopeless without the other and both are inseparable.

A NOTE ON *FUSARIUM* WILT OF GRAM IN BURMA AND MEASURES TAKEN TO COMBAT IT.

BY

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In Burma, the gram plant (*Cicer arietinum*) is grown mainly in the Sagaing, Lower Chindwin, Kyaukse and Myingyan Districts of Upper Burma and in Tharrawaddy in Lower Burma. The total area for the year ended 30th June, 1922, was 119,000 acres. The area is thus small compared with that in some Indian provinces, but nevertheless, owing to its being a true cold weather pulse, the crop is one of considerable importance in Burma. It is often grown on land that is too flooded during the rains for paddy cultivation or when *jowar* (*Andropogon Sorghum*) fails for want of rain, and in the Sagaing and Monywa Districts it is the only suitable crop for rotation with wheat. The result of this is that any circumstance that makes gram growing difficult or impossible leads to the necessity for growing wheat crops for successive years on the same soil with the usual result of diminished yields and profits, while in other cases it may prevent cultivators from getting any crop at all. If possible, the rotation adopted is a two-year one of wheat and gram, no other crops being grown.

The soils of the wheat-gram tract are heavy black clay loams, very similar in appearance and texture to the "black cotton" soils of Central India and the Deccan. The Burma so-called "black cotton" soils are alluviums of great depth and the underlying rock does not reveal itself except when very deep borings are made. Their origin is probably local, and they perhaps represent the last stage in the erosion of the original tertiary rocks. Another theory is that they are old lake bottoms but the Geological Survey

have, I understand, abandoned this theory. The Burmese name of these soils is " Sanè " and they occur over most of the Swebo and Mandalay canal systems, along the railway line in the Sagaing and Monywa Districts, and in isolated patches in many other parts of the dry zone of Burma. In Upper Burma, gram is grown principally on these " Sanè " soils, but in Lower Burma, cultivation is mainly on the riverine alluvium, i.e., on land which is flooded annually during the rains and cropped in the cold season.

Gram is usually sown in late October or in November, the soil having been previously ploughed and harrowed. On principle, however, a fine tilth is not usually attempted, as cultivators believe that the crop thrives best when the surface of the soil is left with abundance of large clods of earth. This is, I believe, an opinion also held by gram cultivators in certain parts of India.

During the last six or seven years, the crop has received attention at the Padu Agricultural Station in the Sagaing District which is in the centre of the principal gram tract. For the purpose of varietal testing for yield a large number of gram types from India were placed under observation at this station. Up to 1918, a variety of black gram gave the best results and it was seen that its superiority in yield to the Burmese type resulted largely from the fact that it was more resistant to a wilt disease which was found to attack the Burmese variety. The black variety, however, is not a type which is in favour with buyers in Burma, and attempts were made to get another which would fulfil their requirements and also be satisfactory in the matter of wilt resistance. This has been achieved by a selection from a variety known as Karachi which appears to have been first introduced in 1918. This strain has proved to be resistant to wilt disease, whereas the black gram which was originally said to be resistant has now (in the present year 1923) shown itself to be highly susceptible.

In 1921, the writer decided to get more definite information on the whole subject of wilt disease during the growing season of that year. With this object a yield test between Burmese and Karachi gram (in quintuplicate plots) was arranged both at Padu and Mandalay, and the growing crop in cultivators' fields was kept

under scrutiny over the more important part of the gram area. The condition of the Burmese variety turned out to be worse than had actually been expected. At Padu, the plots of Burmese gram were completely destroyed by the wilt, whereas the Karachi gram plots showed a fine vegetative growth and a good yield of seed with no dead plants whatever. Widespread damage by this fungus was discovered in cultivators' fields all over the gram area of Sagaing and Monywa, along the railway line in the Kyaukse and Yamethin Districts and at Yawnghwe in the Southern Shan States. The fungus was identified by the Mycological Section at Pusa as *Fusarium* sp.—a fungus closely allied to that which attacks *arhar* (*Cajanus indicus*). The damage varied from a slight attack to almost complete destruction of the crop as at Padu. Cultivators state that they can only escape the effects of the disease by abstaining from sowing gram on the same field for five, six or even (as I was informed in one case) for ten years. As usual the only possible rotation crop is wheat, and this means continuous cropping of the latter with the consequent fall in outturns. In some parts of the Sagaing District the attack was so bad that cultivators were found to refer to their gram fields as "kalape thingyine" or gram graveyards. To sow seed in them was like burying a dead man—nothing ever came up. On the other hand, the Burmese gram plots on the Mandalay Agricultural Station showed no signs of disease, the obvious explanation being that gram had never been grown on them before. In 1922 no attack was reported from the Tharrawaddy District in Lower Burma where most of the crop is new, a large increase having taken place in response to the higher price got for the product in recent years. In 1923, however, closer inspection proved definitely the existence of the disease in the Lower Burma gram areas in the Tharrawaddy and Bassein Districts. The Padu area in the Sagaing District, where the cultivation is old, is obviously very badly infected. It was probably about here and near hand at Ava, the old capital of Burma, that gram was first introduced into Burma from India. That it was so introduced is apparent from its Burmese name "kalape" which means "Indian" or "foreign" pulse. Hence we would expect to have happened what we actually

do find, viz., that the soils of these parts are most highly charged with the disease. A good deal of the gram land in the Sagaing District about Padu is also low-lying and is under water during part of the rains. These conditions, as Butler points out (*Fungi and Disease in Plants*, page 35), are also conducive to increase of this disease, the spores of the fungus tending to be washed down by the rains and to accumulate in the lower areas.

In addition to the varieties already tested, the writer also obtained, through the courtesy of Mr. A. Howard, some seed of each of the 25 types described in *Pusa Memoirs, Botanical Series*, Vol. VII, No. 6. A line of each of these was grown on infected soil at Padu during the past two seasons of 1922 and 1923. Of the 25 types, Nos. 1 to 9 completely succumbed, Nos. 10, 14, 16 and 24 were attacked but not completely destroyed. The rest seemed to be resistant but, with the exception of No. 20, they appear to be too late for Burma conditions.

The behaviour of the black gram mentioned above would appear to indicate that varieties become progressively susceptible but the data available are not sufficient to prove this. Material to test this fact is now at hand in the Karachi and some of the Pusa varieties which have up till now shown themselves completely resistant. Further sowings on infected land will be done with these next year and in successive years and careful counts made in order to get information on this very important point.

That varieties of cultivated plants can become increasingly susceptible and that a variety which is resistant in one locality may be non-resistant in another has been pointed out by Butler in an article on "Immunity and Disease in Plants" in the *Agricultural Journal of India*, Vol. XIII (1918), Sci. Con. No.

In the meantime, the Karachi variety has shown itself so completely superior to the Burmese variety that as seed of it is now available in large quantities, it has been decided to replace the whole existing variety by seed of the Karachi in those localities at least where the disease is known to be prevalent. During the season of 1921-22, seed of the resistant type sufficient to sow 2,500 acres was distributed near Padu and a gram growers' union formed to provide

pure seed for the next season. So great are the losses suffered by cultivators—direct losses owing to the attack of the disease on the gram crop and indirect in that a proper rotation for wheat cannot be got—that in 1922-23 it was decided to accelerate the work. With this end in view 5,000 baskets of seed was purchased back from those cultivators who grew the department's seed in 1921-22, and distribution of this took place before the sowing season of 1922. Distribution of this seed, about 350,000 lb., was arranged through private growers, co-operative credit societies and by Deputy Commissioners giving it as short time loans under the Agriculturists Loans Act. The demand for the seed was great, as the merits of the resistant variety were known to large numbers of cultivators who had been asked to attend a demonstration at Padu while the crop in the plots shown in Plate XXIII was on the ground. During the season the Land Records Department were asked to provide an independent estimate for the area under the new variety. This was returned as 28,000 acres. The initial progress has been satisfactory, and it is certain that by continuing the distribution for two or three years more the desired object will be achieved. In places where disease has not appeared it may not be so easy to convince cultivators of the necessity of a change of seed. In fact the test at Mandalay has shown that where disease does not exist the Burmese variety can hold its own with the introduced. Whenever the least signs of disease are seen, however, a vigorous policy to oust the old variety will be undertaken in order that the state of matters now existing in the disease-stricken areas may not arise.

In connection with this gram work several points of special interest deserve emphasis and recapitulation:—(1) The extreme virulence of the *Fusarium* wilt in certain localities; (2) the actual existence of gram types in India which are at least temporarily resistant and the discovery of which affords a rapid and easy method of relief to cultivators; (3) the very interesting question mentioned above as to how far any type is permanently immune to the disease. In any case it does not appear that so far as gram varieties are concerned there is any literature dealing with this aspect of the

PLATE XXIII.

RESISTANT AND SUSCEPTIBLE GRAM VARIETIES AT THE PADU FARM, BURMA, FEBRUARY 1922.

(A line of soy-bean used to demarcate the plots. An identical result was got in 1923.)

matter, and the first thing to be done is to ascertain definitely whether such deterioration does take place or not.

The replacement of the existing variety in Burma by an immune, or at least highly resistant, variety will mean an increase in the value of the crop of at least five lakhs of rupees per annum.

It is possible that the facts disclosed in this note may be of interest to mycological experts and those officers of the Agricultural Department whose duties lie in the great Indian gram growing areas. Little or no information seems to be available as to the incidence of the wilt disease of gram in India, or the number of really resistant varieties which exist in the country.

EXPERIMENTS ON WHEAT THRESHING AT LYALLPUR.

BY

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OUT of a total of over twenty million acres of wheat grown in British India, the Punjab has annually to its credit over nine million acres, or 35 per cent. of the total wheat of the country. Its enormous importance in this province is even better realized when it is stated that, in the canal colonies, the cultivator sows annually eleven or twelve acres of wheat in each square of his land (about 40 per cent.). No research can, therefore, be of greater importance to the Punjab cultivator than anything done in connection with the wheat crop.

The process of harvesting and threshing this crop is a long and laborious one, severe on man and animal, since the work falls at the hottest period of the year. Practically the whole crop is still harvested by hand. Some reaping machines are, it is true, in use, but the area at present covered by them is so small as to be almost negligible. The threshing and preparation of the grain for marketing is, however, a much slower and harder task, in comparison, than the actual cutting. For the zemindar the mere extraction of the grain from the ears is only one phase of the work. He requires in addition that the straw shall be crushed, and broken into very fine pieces (*bhusa*). For generations this has been accomplished by the tedious process of trampling by bullocks with *phalla*. Four bullocks and three men can normally thresh, and make

bhusa of, one acre of wheat in one day. The average zemindar owning a square of land in the canal colonies has four bullocks. He grows eleven or twelve acres of wheat, hence it will be seen that the threshing and *bhusa*-making operations alone take the same number of days. It is customary for the winnowing to be done by casual labourers who receive 5 per cent. of the cleaned grain for their work. If winds are unsatisfactory, this operation may be a very prolonged one. Storms, too, often cause heavy damage, hence early finishing of the work is important.

About 1907, the Punjab Agricultural Department started some experiments on wheat threshing by machinery. The first machine tried contained a threshing drum and concave only, the power being obtained from a bullock-driven gear. It, however, was not a success, and was discarded. About 1911 the department procured two large Ransome threshers of the N. I. L. type driven by a steam engine. Work was continued with them up to 1915. One was a 30-inch, and the other a 48-inch machine. The smaller one gave an output of 4·6 maunds, while the larger machine gave about 10·5 maunds per hour.[1] These machines were sent to Mesopotamia during the war and did not come back, so work on this subject was temporarily interrupted.[2]

In 1920, two portable, self-driven threshers were brought out from England. These machines were introduced with the object of lessening the difficulty and waste of time associated with the transport and alignment of the ordinary steam engine and thresher outfits which had been tried earlier. It was also thought that they might save much time and labour in the threshing of the wheat, gram, etc., grown on the numerous small experimental plots at the Lyallpur Agricultural Station.

The smaller machine (Fig. 1) is constructed of wood and mounted on iron travelling wheels without springs. Its length is 16 feet 6 inches, width 4 feet 6 inches, height 8 feet, and weight about 36 cwt. A 5 h.p. oil engine is installed at one end of the frame

[1] The working of these machines is described in the *Agri. Jour. Ind.*, X, Pt. 3.

[2] A machine similar to these was tried at Cawnpore in 1913. *Agri. Jour. Ind.*, VIII, Pt. 4.

underneath the shakers. The power is transmitted to the threshing drum by a belt, which, to facilitate easy starting of the engine, can be moved to a loose pulley. Subsidiary belts, working from pulleys on the drum, operate riddles, shakers and fans. The drum, which is 24 inches broad, is of the skeleton type, with

FIG. 1. 24-inch self-driven thresher working at Lyallpur.

beaters in which pegs ($1\frac{1}{2}$ inches long) are inserted. The concave bars also contain similar pegs. The straw shakers are on the reciprocating principle driven by a single crank. The separations are effected by two riddles with a blast of air passing between them. The grain is raised up for bagging by the usual belt and bucket elevator. The feeding platform is about six feet from the ground, and from this the bundles are fed to the drum horizontally. The threshing action of the drum is a combined beating and combing one. The beaters, acting downwards at right angles to the feed platform, deal very severely with the straw, breaking fully 50 per cent. into coarse *bhusa*. Most of this broken straw passes with the grain, chaff, etc., through the concave and shakers. This bulk is greater than the machine can deal with, and causes choking at the entrance to the caving riddle. This always occurs after ten or fifteen minutes' working, and the time wasted in

cleaning out the obstruction again is usually more than the time spent in threshing. To minimize this fault wide setting of the concave was tried, but the proportion of *bhusa* made was still too high for the machine to deal with. Slow feeding was also tried but without any improvement. Oats, wheat and gram at different stages of ripeness were then threshed, and it was found that if the straw was tough the machine worked very well, its success depending entirely upon the condition of the straw. The highest output of wheat obtained was six maunds per hour. This figure is much too low for the machine to be economical.

The larger machine (Fig. 2) is also constructed of wood, spring mounted on iron travelling wheels; its length is 17 feet, width 4 feet, height 8 feet and weight about 40 cwt. The motive power is supplied by a 6 h.p. horizontal oil engine, also installed within the frame. The internal arrangements of this machine are almost similar to the other with the exception of the drum and concave. This drum (27 inches

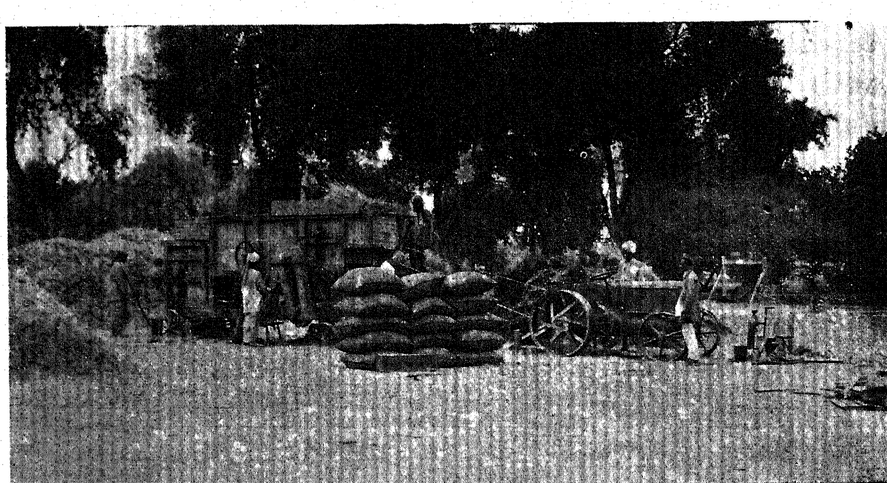

FIG. 2. 27-inch thresher with *bhusa* maker attached.

broad) is of the high speed rubbing type, whilst the concave in this case is in two sections, the whole making an arc of 180 degrees. The feeding platform here is on top of the machine. The bundles being fed into the drum at a tangent caused the grain to be extracted from the ears more by a rubbing than beating action; this resulted in a

lower percentage of *bhusa* and less choking in the machine. Setting of the concave to suit conditions played a very important part. If the concave was set too wide, whole heads were broken off and passed through the machine unthreshed; if set too close, a small percentage of grain was broken, and much *bhusa* made, accompanied by the usual choking and flooding of the riddles. The output of this machine averaged about eight maunds per hour.

The caving riddle which is the first to deal with the large bulk of broken straw, grain, chaff, etc., is too small, being only about 6 square feet in area. The clearance between it and the shakers is also not enough, being only about 6 inches. With the idea of trying to remedy its faults, this machine was taken to pieces and reconstructed. New shakers were made and covered with woven wire ($\frac{1}{2}$ inch mesh) to try and prevent the *bhusa* from falling through to the riddles. The space between the shakers and caving riddle was enlarged, and the superficial area of riddles increased four times. On trial after reconstruction it was found that the shakers were effective in stopping most of the *bhusa*, also that the larger riddles were capable of dealing effectively with all the material thrown upon them. Further, the output of the machine was almost doubled. Owing to its narrowness, this machine is very difficult to feed. The sheaves have to be inserted heads first into the drum which, instead of sucking them away whole, cuts the straw off in pieces. Hence the operator has to keep continually pushing them in. This makes feeding very tiresome, and unless men are changed often considerably lowers output.

With this thresher a separate small machine for making *bhusa* was provided. It consists of two small drums, the first being fitted with numerous cutting sections much resembling those on the knife of a reaping machine. These alternate with similar sections fitted to a concave. The straw on passing between them is chopped up into a fine condition and then passes to the second drum which is fitted with conical pegs. Between these and another concave containing similar pegs it is thoroughly bruised. This machine makes very good *bhusa* but suffers from the fault that, as designed, the thresher and *bhusa* maker cannot be worked simultaneously by

the engine. Actual threshing had to be done first and *bhusa* making later. In the subsequent reconstruction of this thresher, the *bhusa* maker was fitted on so that the straw on being delivered by the shakers passed into it and was finally ejected as *bhusa*. This, however, necessitated the removal of the engine which drives the thresher, and a tractor had to be employed to supply the driving power. Whilst all the operations could thus be performed at once, it was not economical as the small oil engine runs at a much lower cost than a tractor.

Both these machines working under European conditions would probably give satisfaction, but they are unsuited to a dry climate like that prevailing in the Punjab, where the straw of ripe grain will never be found tough as it is in England.

The framework of both machines gave much trouble, due to the wood warping and joints working loose. Where lubrication was not automatic, bearings caused many delays by heating up. The temperature in the threshing season is anything from 100° to 150° F. in the sun, and for this reason machines constructed of wood are almost certain to have a short life here.

Another "all steel" thresher was tried last harvest; it is also portable, about 10 feet long, 5 feet broad, 5 feet high, and weighing about 20 maunds. The driving power was supplied by a tractor. Simplicity is the dominating feature in this machine as it contains drum, shakers and fan only. Its 42-inch broad drum is of the high speed rubbing type. Owing to its breadth this machine was very easily fed, the sheaves being thrown into it diagonally. The output was about 16 maunds per hour. Its great drawback is that it only partially cleans the grain. Fewness of working parts is its strong point, as it can be run almost continuously without stopping from mechanical troubles, etc.

When the wheat crop is being cut, the prevailing custom is to tie it up in large bundles weighing over a maund with heads and butts all mixed up. These bundles are much too unwieldy to lift on a threshing machine, besides when heads and butts are mixed the drum will not readily take it in. Here, for convenience, we have adopted the English system of tying it in small bundles

about 9 inches in diameter with heads all in one direction. These are easier to handle and more readily taken in by the machine.

The general conclusion arrived at as a result of these trials is that the simpler and less complicated the machine, the more likely will it be to achieve practical success here. Its chief aim should be to thresh well both as regards quality and quantity and to effectively separate grain and straw. It is, however, strongly felt that no machine will be entirely successful, or in much demand here, that does not turn out the threshed straw in the form of *bhusa*. The Punjabi zemindar has from time immemorial fed his straw in this state, and discussion with him on this subject invariably shows that it is one of the first requisites in a machine which he will demand. Neither of the two small wooden self-driven machines can be recommended. Their outturn is much too low, the quality of their work poor, and the material of which they are made unsuited to the climate. The small all-steel thresher already described is a much better machine than either of these. Its outturn is very fair and the quality of the threshing good. Driven by an oil engine of 6 b.h.p., it can be run very economically. Some small alterations in its construction were deemed advisable, and it is hoped to have the privilege next year of trying another such machine embodying some of these alterations. Its only drawback, so far as can be foreseen, is that the straw after being threshed will have to be converted into *bhusa* by other means. Out of all the machines so far tried, the full size steam-driven machine producing *bhusa* appears still to hold the premier place.

Selected Articles

ROTHAMSTED AND AGRICULTURAL SCIENCE.*

BY

SIR JOHN RUSSELL, F.R.S.

THE Rothamsted Experimental Station has just passed its eightieth year, having been founded in 1843. Its study has always been the growth of crops, with periodical excursions into problems of utilization; the method of experiment has always been essentially statistical in that the field experiments were repeated year after year without modification, with the result that a unique mass of data has now accumulated which is proving of the greatest value for statistical investigation.

The work at Rothamsted falls into two great periods: the first when Lawes and Gilbert were actively exploring the possibilities opened up by the knowledge of plant nutrition gained by the early nineteenth-century workers; and the more recent period, when close study of the soil has revealed certain factors of high scientific interest, and, one is constrained to believe, ultimately of great practical importance.

The great problem which Lawes and Gilbert set out to solve was to account for the fertilizing value of farmyard manure. The fact was well known, but there was no satisfactory explanation. Lawes and Gilbert proceeded by a method that still—after eighty years—remains our best. It was known that farmyard manure contained three groups of components: organic matter; nitrogen compounds; and ash constituents—potassium, calcium and magnesium salts, phosphates, silicates, etc. They therefore arranged

* Discourse delivered at the Royal Institution on 9th February, 1923. Reprinted from *Nature*, No. 2788.

vegetation tests with these various groups. The old idea was that the fertilizing value lay in the organic matter, but Liebig, in 1840, had argued brilliantly against this view, and suggested instead that the ash constituents, especially the potassium, calcium and magnesium salts, were the effective agents. Lawes and Gilbert were prepared to recognize the necessity for these mineral salts, but insisted that the nitrogen compounds were equally required. To put the matter to a test, they laid out four plots of ground, receiving, respectively, no manure, farmyard manure, ashes of an equal amount of farmyard manure, and these ashes plus a nitrogen compound (ammonium sulphate). The results were as follows :—

Produce of wheat per acre, Broadbalk Field, Rothamsted. 1844.

	Grain (bush.)	Straw (cwt.)
No manure	16	1,120
Farmyard manure (14 tons per acre)	22	1,476
Ashes of 14 tons of farmyard manure	16	1,104
Ash constituents + nitrogen compounds and ammonium sulphate, up to	26¼	1,772

They concluded that farmyard manure owes its value, not to the organic matter as was for long supposed, nor to the ash constituents as Liebig had suggested, but to the ash constituents plus nitrogen compounds.

Now this discovery was of the greatest importance in plant physiology, but Lawes and Gilbert did not follow it up in that direction. Instead they applied it at once to an important agricultural problem then ripe for solution. There was then (as nearly always now) a shortage of farmyard manure on farms, and agriculturists had for generations sought for substitutes, but with little success. Lawes and Gilbert saw that the mixture of ash constituents and nitrogen compounds would form an effective substitute, and further, that it could be obtained in very large quantities, and of course independently of farmyard manure. Geologists had discovered vast deposits of calcium phosphate, which chemists had shown how to render soluble. Engineers were developing the manufacture of coal gas and producing large quantities of ammonium sulphate, while potassium compounds could be obtained without difficulty from wood ashes. Lawes and Gilbert therefore

proceeded to make mixtures of these substances which they advised farmers to use.

Few experiments have proved so fruitful in stimulating scientific inquiry—it is still opening up new fields at Rothamsted—and in ministering to human needs, as this simple field trial carried out eighty years ago on the Broadbalk field at Rothamsted. At first farmers looked with some misgiving upon this new kind of manure (which was called "artificial manure" to distinguish it from farmyard manure, then known as "natural manure"); it seemed incredible that a harmless-looking powder without smell or taste could act as potently as the old-time richly odorous farmyard manure. But they soon came to recognize its value, and before long they were using many thousands of tons a year. It is safe to say that the remarkable development of British agriculture which took place between 1843, when Rothamsted began, and 1870, would have been impossible without artificial fertilizers. During that period British farmers kept pace with the growing needs of the population; indeed they did more, for they helped to change the "hungry 'forties" into the more plentiful 'seventies. The use of artificial fertilizers is now developed throughout the civilized world and the industry has attained enormous dimensions.

This was the greatest achievement of Lawes and Gilbert. They did many other things for the farmers of their day, but this alone leaves us owing them a great debt of gratitude.

As the use of artificial fertilizers spread there arose, as one might expect, many problems of great scientific interest or technical importance. Thus it soon appeared that weather conditions profoundly affected the response of crops to artificial fertilizers. The same fertilizer mixture which in one season gave results fully equal to, or even surpassing those of farmyard manure, would, on the same farm and even in the same field, prove a failure in another season. This is well shown in the fluctuations in yield on the Broadbalk wheat field at Rothamsted.

The effect of soil is also sharply marked. On our heavy soil at Rothamsted the best results are usually obtained by a fairly liberal use of phosphate, but there is less necessity for large dressings

of potash. But on the much lighter soil of Woburn potash is considerably more important, while phosphates are less needed, and, indeed, beyond a certain quantity appear to do actual harm. It is obvious, therefore, that a complete manure drawn up on the basis of the Rothamsted experiments would fail in practice to give the best results on a lighter soil. As an instance the following may be quoted, this being one of a general scheme of experiments organized from Rothamsted :—

Barley : Light sandy soil in Suffolk, 1922.

	Bush. per acre
Complete artificial manure	21·5
Incomplete manure : phosphate omitted	27·5
No manure	16·0

In this instance the omission of phosphates has raised the yield by 6 bushels per acre. As against this, an array of instances might be brought from clay farms where a phosphate is the one and only thing that causes crop increases. Any one who had to deal with farmers' problems could multiply apparent contradictions and inconsistencies of this kind. When one collects, as we have done at Rothamsted, the results of field trials with artificial manures made in different parts of the country, they seem at first to be simply a tangled mass of unrelated facts.

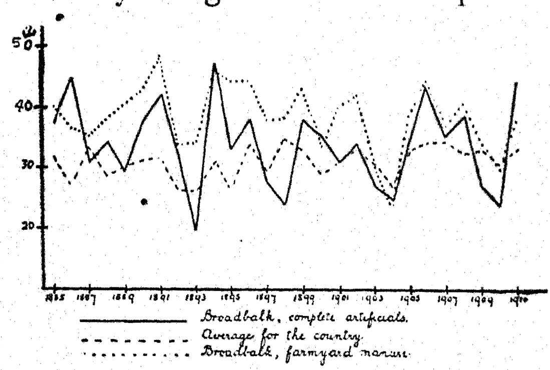

FIG. 1. Yields of wheat from Broadbalk plots manured with complete artificial manures, and farmyard manure, respectively, compared with the average yield for the whole country.

Now it is the business of the man of science to sort out a tangle of this kind, to reduce it to order, to find the general principles running through it, and finally to prove the correctness of his conclusions by being able to predict with certainty what will happen in given conditions. The recognized method of procedure is to discover the various factors at work and investigate them one at a time.

This is being done at Rothamsted in two ways: by field observations, and by quantitative laboratory measurements. Observations in the field show that each of the fertilizing substances—phosphates, potassium compounds, nitrogen compounds, etc.—in addition to its general effect in increasing plant growth, produces certain specific effects which may be of advantage, or may be a disadvantage to the plant in the particular conditions in which it happens to be growing. Thus, phosphates have a special influence in hastening the ripening processes, which no doubt accounts for the Suffolk results just quoted. In the dry conditions of a sandy soil, ripening is already too early, and any reduction in an already short growing season cuts down the yield; in cold, wet districts, however, this property is very valuable.

In the early stages of the plant's life phosphates stimulate root development to a marked degree; this is well shown in their effect on swedes. Nitrogen compounds tend to increase leaf development and give greater vigour of growth, but beyond a certain point the advantage is counteracted by a loss of resisting power, and the plants may fall victims to attacks of disease. Crops—especially cereals—may be unable to stand up against the weather and may become "lodged." Indeed, the proper adjustment of plant nutrients affords plant pathologists one method of dealing with plant diseases.

Qualitative observations of this kind, while of high value, are not entirely sufficient: it is necessary to have quantitative measurements of as high an order of accuracy as possible. At Rothamsted this is done by means of water cultures and pot experiments; all the factors are controlled as closely as possible and the results are plotted on curves which can be studied in detail. This method was developed extensively by Hellriegel and is now in common use in agricultural laboratories.

The method naturally invites mathematical treatment, and attempts have been made, notably by Mitscherlich, to express the curve by equations. There is a seductive look about a mathematical formula which rarely fails to appeal to the biologist, but as a rule the number of experimental points obtained is much too

small to justify mathematical treatment, and it is not surprising that investigators fail to agree. Ten years ago the fashion was for logarithmic curves; now it is for sigmoid curves, which are probably nearer the truth, though not yet a complete expression.

This method of studying single factors is pushed to a high degree of refinement in plant physiology laboratories, such as that of the Imperial College under Prof. Blackman, or that under his brother at Cambridge, and there can be little doubt that the effect of individual factors on the plant will ultimately be well known. All this work is giving valuable information as to causes and principles.

These curves show the relationship between yield and plant food supply at one particular temperature which remains constant, and one particular water supply which also remains constant. But a completely different set of figures would be obtained if the temperature were different or if the water supply were altered. Supposing one wished to take account of the effect of water supply as well as food, one would draw a series of curves, which would properly be expressed as a surface, and this has been done by one of the Rothamsted workers—Mr. J. A. Prescott—to show the effect of nitrate supply and spacing on the yield of maize in Egypt. The experiments had the advantage that the climatic conditions are less fickle there than here. It would be of the greatest interest to obtain such surfaces for other pairs of factors.

If an attempt were made to study factors three at a time, it would be necessary to prepare a series of surfaces and to embody them in a figure in four dimensions, which is certainly beyond the capacity of the ordinary agricultural investigator. But in agricultural field work the factors do not vary one at the time, or even two or three at the time; there may be half-a-dozen variables. This, of course, enormously complicates any attempt to apply to field conditions the results obtained by these single factor physiological experiments. It is possible that when the physiologists have completely elucidated all the single factors, some one will be able to synthesize the material and build it into some great conception or expression that will contain all, and thus account for the field results.

But history shows that the genius capable of effecting a synthesis of this sort is very rare and might have to be awaited long.

We have therefore adopted another method at Rothamsted, which is being worked alongside of the single factor method. Statisticians have, during recent years, been evolving methods for dealing with cases where several factors vary simultaneously. These methods have been applied by Mr. R. A. Fisher to the Rothamsted field data, and he has been able to trace certain statistical regularities which foreshadow the possibility of important developments.

Thus, the yields on the Broadbalk wheat field vary every year, apparently in a most erratic manner. But analysis of the figures showed that the factors causing variation could be disentangled and expressed quantitatively; there are slow changes in the field, such as changes in the amount of weeds, etc.; deterioration of soil; and weather changes such as rainfall, temperature, etc. (Fig. 2.)

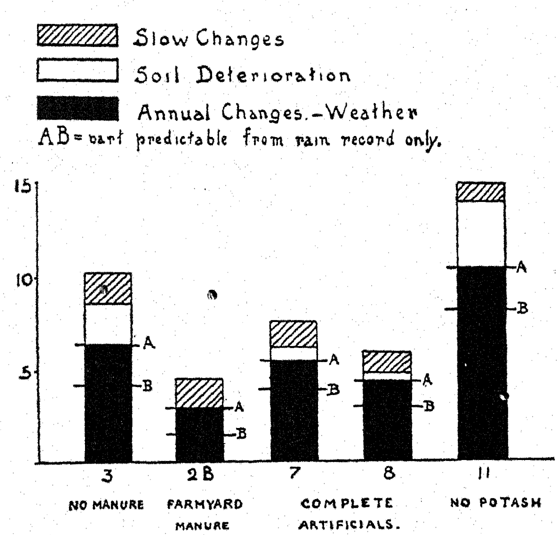

FIG. 2. Mr. R. A. Fisher's results showing amounts of predictable variation in wheat yields, Broadbalk, Rothamsted.

As might be expected, the effects differ according to manurial conditions; e.g., the influence of weather varies with the manure. Important differences appear between farmyard manure and artificials. The variation in yield is less where farmyard manure is given than where artificials are used. Further, the so-called complete manure appears not really complete at all; there is soil deterioration going on; but with farmyard manure no such deterioration is produced. The different kinds and quantities of artificial manures produce different effects on the variation in yield, the magnitude of which has been worked out.

Having disentangled the factors Mr. Fisher has proceeded to analyse the effect of rainfall, and he finds that part of the weather effect is predictable when rainfall is known. Rain above the average in autumn is somewhat beneficial; in winter and in summer it is harmful, and in spring it is less frequently harmful. As before, the effects are much more pronounced with complete artificials than with farmyard manure. The actual facts have long been known in a general way, but here is an exact quantitative measurement.

The great advantage of this statistical regularity is that it indicates the possibility of expressing in terms of chance the influence of the weather, soil, etc., on crop yields. We hope ultimately to be able to say to the farmer, given such and such conditions of soil and weather, the chances are so many to one that such and such an increase of yield will be obtained by the use of a specified fertilizer. The expression would be understood by every farmer, and he would readily decide whether to take the risk or not.

Much greater results would also follow. At present the farmer cannot cover his risks of low yields by insurance, the companies not yet having sufficient data. We hope and believe that these statistical investigations will afford the basis on which such data will be obtained. At present the position approximates to that of life insurance in the eighteenth century, when the statistical regularity of mortality was first established, after which the first life tables could be constructed. There still remains a mass of detail to work out, but the fundamental problems are now being attacked, and we see no reason to regard them as insoluble. If the expectancy of crop yields proves to be calculable the farmer will be able to insure himself against crop failure, and so meet one of the worst vicissitudes of his troubled life by merely taking out an insurance policy—perhaps even by subscribing to a particular newspaper.

We are constrained to admit that the work is still far from completion, and in the meantime agriculture has fallen on difficult days and farmers are turning to us to ask how they can obtain large crops in the most economical way. It is not general principles they want, but particular instructions.

We are not in a position to give an absolute clear cut prescription to any farmer, but we are going a long way to meet him. Some of our field experiments of special interest or importance are being repeated at other centres where soil and climatic conditions are all different. The results are compared with ours, or with others that have been obtained, to ascertain how far or in what direction any of our conclusions would need modification in a particular district.

We now return to an important result to which I have already referred. Over a period of years the artificial manures have not proved quite as effective as farmyard manure; there has been more variation in yield and they have not so well maintained the fertility of the soil as farmyard manure has done. On some crops the effect is marked; clover responds better to farmyard manure than to artificials. It appears then that Lawes' and Gilbert's views that the fertilizer value of farmyard manure lay in its ash constituents plus nitrogen compounds is only a first approximation, and that farmyard manure does something or contains something which artificial manures do not. This difference we are now engaged in exploring.

The same method of procedure is used as in studying the effects of artificial fertilizers. A full scientific investigation into the causes is carried out, but simultaneously an attempt is made to find some working solution of the farmers' problems. The shortage of farmyard manure is still as acute as ever, and to keep more animals with the view of making more is uneconomic. At Rothamsted we have attempted to produce farmyard manure from straw artificially and without animals. This has been done by Mr. E. H. Richards and Dr. Hutchinson by simulating the essentials of the natural process, namely, watering straw with a salt of ammonia (actually ammonium sulphate, but calcium carbonate is mixed with the straw), and leaving the heap so that the air can get in and the organisms can do their work. The product is not yet equal to the natural substance, but it is steadily being improved, and the very serious difficulties are gradually disappearing in Mr. Richards' competent hands. Five years ago a few ounces only of this artificial farmyard manure had been prepared; last year several thousand

tons were made on various farms in different parts of the country, and the news is spreading. The serious problem of developing the work from the laboratory to the farm scale has been possible through the generous and public-spirited action of Lord Elveden. There seems here the possibility of aid to the farmer and of the development of an important new industry.

Meanwhile a full scientific investigation is being carried on to discover wherein farmyard manure differs from artificials. One important difference is already known and is being investigated by Dr. Keen. Farmyard manure opens out the soil particles leaving bigger pore spaces ; it allows of the retention of more moisture and the better circulation of air. All these effects are beneficial.

There is also another difference. Farmyard manure and also plant residues (which are substantially the same thing) decompose in the soil, giving rise to many substances of different types. The plant foods are among the end products: indeed, in natural conditions, and, to a large extent, in farms and gardens also, it is in this way that plants obtain their food. In using artificial manures we supply these end products at once instead of waiting for them to be liberated gradually by the natural decomposition. Further, we do not by any means know the whole of the processes whereby plant food is made. But there are certain intermediate products, and it is quite possible that some of these may have a special effect on the growing plant. Curious stimulating effects are produced by substances formed when soil is steamed, or when oxidation is accelerated by addition of charcoal, and we have obtained the same results with small quantities of picric acid ; such bodies might well be formed as intermediates in the decomposition of farmyard manure. The whole effect suggests an action like that of the vitamins of plant physiologists or the auximones of the late Prof. Bottomley. The chemical department at Rothamsted, under Mr. Page, is following out the process, and the botanical department, under Dr. Winifred Brenchley, will test any intermediate products which may be obtained.

A further important factor, which probably governs the whole situation, is that a great part of the process of decomposition

and plant food production appears to be brought about by living organisms in the soil. Simultaneously, therefore, with the chemical and botanical investigations, the various biological departments are busily engaged in studying the organisms that are doing the work.

It is a wonderful story that is being revealed. The soil is shown to be the abode of a vast population of living organisms of the most varied kind. Some of them are remarkably small; among them one which brings about the last stage in the formation of nitrates—an organism which Rothamsted just missed forty years ago: another, also just missed at Rothamsted, which has the remarkable property of fixing nitrogen in the nodule of the clover plant. Others are larger and more easily picked out, but their exact place in the soil economy is not easy to determine: probably they are concerned in the preliminary stages of the decomposition.

It is impossible to peer into the soil with a microscope, so that indirect methods of exploration have to be used. At Rothamsted the organisms are counted and the work they do is estimated by some chemical process: virtually we take a census of population and production in the soil. Like other census methods, it is comparative only: a single census is not much use; it is not until several have been taken that one can find how the numbers and activities of the population are being affected by various conditions. The census is therefore repeated periodically and the results plotted on curves from which it is possible to deduce the effect of various factors on the particular organisms counted.

These curves brought out the remarkable result that partial sterilization increased bacterial activity, and investigation showed that the normal virgin soil must contain other organisms besides bacteria—organisms, moreover, which were detrimental to bacteria and tended to keep their numbers down. A search for such organisms showed that protozoa were present: many forms have since been found in the soil, some of which are known to feed on bacteria. Mr. Cutler has discovered how to count them, and with the co-operation of willing workers has succeeded in carrying out perhaps the most remarkable census yet made of the bacterial and protozoan population of a natural field soil. Before the census

began many months were spent in perfecting the methods and technique, and in making preliminary studies of the soil. The details were carefully arranged with the statistical department, and it was decided to take the census many times at short intervals. Time to a bacillus or a protozoan is a different thing from what it is to us, and instead of taking the census every ten years, or even every ten days, it was taken daily, and at the same hour every day. Many repetitions were needed so that the statistician might feel safe in drawing conclusions from the data. The census was therefore made every day for 365 consecutive days, and no less than seventeen different organisms were enumerated.

A team of five workers kept the investigation going without intermission—Sundays, Bank Holidays, and Christmas Day—for a whole year. A mass of data was obtained of high statistical value which is proving of the greatest importance in the study of the soil population. One of the most interesting results was the proof that the soil population is not steady in number as had always been assumed, but is in a violent state of flux. Every organism observed—protozoon or bacterium—showed great daily variations, which seemed to be independent of external conditions. At least one showed a two-day periodicity. The fluctuations of the amœbæ were of special interest as they were exactly the reverse of the bacterial fluctuations. Close examination of the curves leaves no doubt that the fluctuations of the amœbæ cause the fluctuations of the bacteria, high numbers of amœbæ causing low numbers of bacteria, and low numbers of amœbæ allowing bacterial numbers to rise: but why the amœbæ fluctuate remains a mystery.

In the case of bacteria it has been possible to make even closer observations. A census organized by Messrs. Thornton and Page has been taken each two hours for several days and nights; but again the same wonderful fluctuations are seen. As might be expected, the amount of work, as measured by the nitrate present, alters from hour to hour. But the curve was not quite what was expected: the increases in amount of nitrate could be understood as representing the work done by bacteria, but the decreases were more difficult to explain. There was no rain to wash it out and

there were no plants to take it up; yet the nitrate tends to disappear. The results suggest that some organism is absorbing it. Algæ and fungi could both do this, and both are found in the soil: Dr. Muriel Bristol and Dr. Brierley are closely studying them.

Perhaps even more remarkable than the daily changes are the great seasonal changes. It appears that the whole soil population is depressed in winter and in summer, and is uplifted in spring and autumn. How this comes about we do not know. The phenomenon does not seem to be confined to the soil; the algæ in a pond and the plankton in the sea, like the organisms in the soil, all seem to feel the joy of spring; it is as if Virgil had got hold of some great truth in natural science, which we have not yet been able to express in cold scientific terms, when he says that in spring "Aether, the Almighty Father of Nature, descends upon the earth, and blending his mighty frame with hers, gives life to all the embryos within." ("Georgics," Bk. II, 11, 324-327.)

The number of organisms in one single gramme of soil—no more than a teaspoonful—often well exceeds 40 millions. This looks big, but it is difficult to form an idea of its immensity. If each unit in the whole array could be magnified up to the size of a man and the whole caused to march past in single file, they would go in a steady stream, every hour of the day and night for a year, a month and a day, before they had all passed. We must think then of the apparently lifeless soil which we tread beneath our feet as really throbbing with life, changing daily and hourly in obedience to some great laws which we have not yet discovered; pulsating with birth, death, decay, and new birth. And if the wonder were not sufficient, we know that in some way these lowly organisms are preparing the food for our crops—the crops on which we ourselves feed. It is possible—it is even probable—that our attempts to learn something of this wonderful population may lead to some degree of control which would have valuable economic results. But even if this never happened the work would still be justified because it shows to the countryman something of the abounding interest of his daily task and of the infinite wonder of the soil on which he spends his life.

DANISH AGRICULTURE AND THE HYGIENE OF THE NATION.*

IN a Chadwick Lecture recently delivered at the Royal Sanitary Institute, Mr. Nugent Harris gave some interesting particulars of Danish agriculture. Forty per cent. of Denmark's aggregate population, which numbers three million people, subsist on agriculture. This figure does not include the South Jutland territories, in respect of which there are not yet available agricultural statistics which may be compared with the Danish figures. No other Danish trade provides occupation for such a large part of the Danish population, and thus we may be justified in describing agriculture as Denmark's main industry. We are still further justified in doing so by the fact that among the trades it is first and foremost agriculture which hitherto has supported the economy of the country, procuring through export 80—90 per cent. of the foreign means of payment which is an essential condition of commerce with foreign countries.

In its present form Danish agriculture came into being in the eighties. During these years an important change was effected by which Denmark, from being mainly a corn-selling country, became a corn-buying country, attaching special importance to the production and sale of animal products, more especially butter, pork and eggs and such live stock as slaughter-cattle and draught-horses. These products constituted about 95 per cent. of the total Danish agricultural export.

The means which Danish agriculturists adopted in order to secure this special production was the breeding of a live stock of a very high quality. In the summer of 1914 this live stock consisted of 567,000 horses, 2,463,000 head of cattle (including 1,310,000 head of dairy cattle), 2,497,000 pigs and 15,130,000 fowls. For the support of this stock not only the greater part of Denmark's own

* Reprinted from *Jour. of Roy. Soc. of Arts*, No. 3687.

crop was required, but also considerable quantities of fodder from abroad, principally about 600,000 tons of oilcakes and about 400,000 tons of maize, the quantity always varying, however, in accordance with the Danish crop. Considerable quantities of artificial manure, nitrate, phosphate, and potash, were required to maintain the quality of Danish soil at the level necessary for such an enormous live stock.

Danish agriculture fell into great difficulties during the war, especially during its last phases, when the tightened blockade rendered it difficult to get supplies from abroad. The most strenuous endeavours were used to ward off and mitigate the effects of the blockade, partly by means of forced home production of fodder, partly by means of special efforts to encourage the best breeding material among the live stock. When the seas were re-opened to the free exchange of goods, Danish farmers at once proceeded to increase to its full extent the live stock which all quarters admitted to be of vital importance to the future economy of Denmark. These endeavours succeeded.

Before the war, 2,463,000 head of cattle existed in Denmark. Of this number, 1,310,000 were milch cows. The annual export of cattle and meat was equivalent to about 300,000 head in all, while the export of butter amounted to about 100,000 tons yearly. The exclusion of foreign fodder had a serious influence on the number of the live stock and impaired its capacity, so that the quantity of milk in 1918 was only about half the normal quantity. But now conditions have become again almost normal, and at the same time the Danish butter market has been extended beyond England, and includes Switzerland, Germany, Sweden and Norway, and even America, to which country considerable quantities of Danish butter are sent. In 1922 there were in all 2,286,000 head of cattle, of which 1,113,000 are milch cows, a somewhat lower figure than that of 1914, but, of course, it has not been the poorest animals which have been preserved, but quite the contrary. The quantity of milk is now almost the same as it was before the war.

Industrial conditions applied more to pig breeding than to any other branch of agriculture, and it was, therefore, a natural

consequence that it should be hard hit by the blockade. But here again special stress was laid on the necessity of keeping the best breeding animals, and these endeavours were crowned with success, so that the number of pigs is now fully one and a half million as compared with only about 513,000 in 1918. It will not be long before Danish agriculture will reach the level of the stocks held before the war, when the number of pigs was about 2·5 million, and when the annual slaughtering at 61 Danish abattoirs amounted to about 3 million pigs.

As to egg production, this became very important during the war, especially for farming in a small way. Here, again, Danish agriculture hopes soon to be able to produce about 500 million eggs annually, and these together with 300 million which are eaten in Denmark, constitute the country's total production of eggs. Buyers for this produce are to be found everywhere.

DANISH AGRICULTURE AND THE REBUILDING OF EUROPE.

It is Denmark's belief that increased production is the only way to restore Europe after the war. Danish agriculture is prepared to take part in this task, and it has—as mentioned above in connection with those branches of production which are the corner-stones in agriculture—kept its capacity in effective order, although not unimpaired. Danish soil, which suffered much on account of the difficulty of importing artificial manures in 1918 and 1919, has now regained its former productive capacity. To this circumstance must be added as an invaluable advantage to Danish agriculture the comparatively quiet labour conditions prevailing in this industry. This is a consequence of a feature which is typical of the social structure characterizing Danish agriculture, i.e., the fact that work on the farms is undertaken to a considerable degree by the farmers' own children, whose term of service is very often only a link in the chain of their education, and one that prepares them for taking over their farms in due course. This is an invaluable advantage which lends Danish agriculture a stability and firmness in production, unmatched in any other industry.

Denmark has become famous for the uniformity and purity in the quality of its main lines of production—butter, bacon, eggs and in recent years cheese. The successful development of its agriculture has also tended to prevent that migration from the rural districts to the towns. The following figures bear striking testimony to this :—

The population of Denmark in 1921 was 3,267,831, of which 1,859,965 lived in the rural districts. This shows an increase of 145,578 over the previous five years, and of 209,615 in the ten years 1911–1921—the men and women about balance in the rural districts.

HOW THE HYGIENE OF THE NATION HAS BEEN AFFECTED.

Diseases that used to be very prevalent have disappeared, others are much reduced in their virulence. A striking instance is that of the Island of Lolland. At one time it was, owing to its low-lying character, subject to very serious floodings by the sea, leaving the soil very damp and boggy. This affected cultivation and produced also very unhealthy conditions, so much so that Marsh Fever (known over all Denmark as the Lolland fever), bronchitis and similar illnesses were very prevalent. These conditions continued until 1903, since when reclamation, drainage and afforestation schemes carried out on a big scale have resulted in modification of practically all these illnesses, and Marsh Fever has been eliminated. The soil is now one of the richest in Denmark.

TUBERCULOSIS OR—AS THE DANES CALL IT—ENGLISH SICKNESS.

In a recent report by the Danish National Society for Fighting Tuberculosis, satisfaction is expressed at the considerable decrease in the number of cases of tuberculosis in Denmark during the last generation, and Professor Faber, in submitting the report, said the tuberculosis mortality figures were now the lowest on record—50 per cent. less than those of 30 years ago—and were second only to those of Scotland, and he gave it as his view that in a few

years Scotland would be beaten. One of the Directors of the Society—Dr. Ostenfield—in speaking of the report, stated that 80 per cent. of the patients in the sanatoria for which they were responsible had been discharged during the year with positive results. The report states that a deficit of 1,293,474 kroner made on the sanatoria during the year was met by the State.

COTTON PRODUCTION AND CO-OPERATIVES.*

BY

A. H. STONE,

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In any comprehensive appraisal of recently developed agencies for the handling and distribution of Delta staples, we should also take account of antecedent economic conditions. In this regard, the outstanding feature of the whole history of tropical and semi-tropical large scale agricultural enterprise is the part played by the factorage system. The English factor, through the seventeenth and eighteenth centuries, bore substantially the same relationship to overseas agriculture and trade that the great banking institutions bear to modern industrial enterprise, if we do not push the analogy too far.

The operations of the system were essentially the same, regardless of crop or place. Before the end of the first quarter of the nineteenth century it had become inseparably identified with cotton production in the Southern States. Its predominant features remained the same. The factor invariably required the consignment of the entire crop, for the sale of which he charged a commission. The planter's basis of credit was usually fixed on baleage. On an advance of so many thousand dollars, so many bales of cotton were required to be shipped. A penalty commission was charged for every bale short of the contract number. There were various charges out of which the factor received a commission or rebate, such as storage, insurance, drayage, etc.

Results of system.

The system had far-reaching economic results. It established one of the most vicious circles possible to any industry. Its emphasis being on baleage, there was every incentive to attempt the

* Reprinted from *The Textile World*, LXIII, No. 17.

impossible in production. The more land a planter was willing to buy on time, the more cotton he could promise, the more money he could borrow, the more slaves he could purchase. It was a business of unusual hazards, for both the factor and the planter. Fortunes were made and lost in it. It was also a business of peculiar fascinations, and many men of large ability engaged in it. It was a business in which social prestige might be enhanced by success, but was not diminished by failure. But the planting end of it was fundamentally unsound, taken as a whole, and Southern students would probably agree that it could not have survived the vicissitudes of many more years, even had there been no Civil War.

Another result was the concentration in a few important cities and towns of practically all of the fluid wealth of the cotton growing South. The interior country, which was practically the sole source of this wealth, was in a state of hopeless economic dependence on these urban centres. Speaking for our own territory, the Mississippi Delta, I may say that this condition of dependence was not relieved until the advent of the mortgage loan companies, about thirty years ago. Even then, there was only a swapping of horses, an exchange of one mortgage for another. But that step had to be taken before even the semblance of a new order could be established. The Delta was tributary to New Orleans, mainly, for sixty or seventy years. At a later date Memphis played an important part in its business life.

The two and a half decades after 1885 wrought very definite changes for the better, in all directions and along all lines. A pronounced aspect of this improved order of things was a change in the method of marketing cotton. And this was practically the first change in a hundred years, or since American cotton became a commercial crop.

Under the changed order, local factors still did a large volume of business, but under a somewhat modified system. Local buyers established themselves in every small town. Local banks were organized. Local compresses and warehouses were built. Rail-roads had made this possible. In short, the market had met the

producer half-way. The next step which followed this change was country buying. Under this it became possible for a planter to sell his crop at his own gin platform. I have referred to this as a change in the method of marketing. And it was not much more than this. The marketing system itself remained practically unaltered. The local factor could sell to the local buyer. Or the local buyer could deal direct with the grower. The grower might be present at every stage of these proceedings. And this change of situs, which made the transaction visible to the eye of the producer, was in reality the only change between marketing in one place and marketing in another excepting of course changes in certain charges, which did not at all affect the system. A psychological change, however, occurred gradually in the producer. Closer contact with buyers, closer connection with his crop after its production, unquestionably caused him to think more and more of the problems involved in converting his product into money, of the problems of marketing and of distribution. There was no longer the blind, unquestioning acceptance of a figure on an account of sale. He at least had an opportunity of knowing by name the man who bought his cotton, and of asking him why he could not pay more for it. He could even refuse to accept an offered price, although the only reason for his refusal was that he just felt that it was not enough.

NEED FOR REMEDIAL MEASURES.

The conditions under which we were attempting to conduct our business in 1920 were almost, if not quite, as unsound as was the system under which our fathers operated in 1860. In fact we, more than they, were out of joint with the progress of the time. There was, therefore, nothing unnatural, nothing revolutionary, nothing strained or artificial about the fact of our seeking remedial measures for a situation which we had come to realize was economically intolerable. I shall venture to suggest that any man who imagines that the means of relief which we finally agreed upon and endeavoured to apply, had no more substantial foundation than a mere effort to satisfy a lurking grudge; that the purpose was to put somebody out of business; that the ultimate end was to create a

monopoly and to reach out and grasp other branches of the cotton trade; that any man who thinks this, or any part of it, has signally failed to apprehend the operation of one of the most elementary, but no less vital, laws of human existence, the instinct of self-preservation.

Details of association.

There is neither mystery nor secrecy about the operations and affairs of the Staple Cotton Co-operative Association. It is in truth a very simple piece of machinery, for accomplishing a very simple purpose. It is composed entirely of *bonâ fide* growers of cotton. It handles only the cotton of its members. It acquires no cotton by purchase or trade. It is allowed to make no profit in its operations. It transacts no business other than such as is incidental to the selling of the cotton of its members. Title to the cotton it handles is vested in the Association. It operates within a well defined area. It is composed of some twenty-two hundred members. In management it is a highly centralized concern, all of its affairs being administered from one office. Its directorate is composed of twenty-one capable and experienced men, meeting monthly, throughout the year, and serving entirely without compensation. Four of these men are presidents of banks and eight others are bank officers or directors. Some of them are lawyers, and good ones. All of them are planters or owners of plantations. The active management of the Association is in the hands of men who devote their entire time exclusively to its affairs, and are paid for doing so. Its sales department is under the direction of a man whom we consider the ablest in the raw cotton end of the staple business. Its president is one of the most successful cotton planters in the South, and is the originator of the idea of a centralized marketing agency in this country. Its accounting department is one of the most efficiently organized and handled which it is possible for modern methods, technical skill and mechanical equipment to develop.

This Association does not seek to establish a monopoly of Delta cotton. It does not handle all of the Delta crop, by any

means. In all its transactions it seeks to observe the best traditions and practices of the trade. It attempts no radical innovations nor freakish experiments. It is controlled by business men, not by politicians. We attempt to secure results through adherence to the principles of established economic law, not by holding conventions and adopting resolutions. The Association seeks to emphasize the personal equation in all its transactions with the trade. It sells only from stocks actually in its own hands. It ships the cotton it sells. It sells for any reasonable period of delivery. It does not in any sense seek to control prices. Its management is not so foolish as to attempt so vain a thing. It tries by legitimate dealing and fair trading through the excellence of its service and the possession of superior facilities and large stocks, to obtain the best possible price for what it sells.

Such an organization as this can exist only through its ability to render service. And this service must include all those with whom it deals, those who buy as well as those for whom it sells.

Not a holding corporation.

I would be less than frank if I did not express concern over the repeated statements that this Association is merely the tangible expression of the disposition and purpose of the grower to hold his cotton. No honest man likes to have his motives impugned and his assurances questioned. I cannot too strongly emphasize the fact that we are a selling concern. No man responsible for the conduct of this Association's affairs would tolerate for a moment a suggestion that we hold our cotton. We will not sell it all at any one time, nor to any one purchaser. Such a transaction would be repugnant to our conception of our legitimate function, as well as in direct contravention of our idea of orderly marketing. Our principle is to sell as steadily as possible, without dumping, in such manner as to dispose of one crop before another comes on. Unquestionably there are honest differences of opinion as to what constitutes orderly marketing. And we have no quarrel with the man who does not agree with us. There is no impropriety in suggesting that our financial connections include a Government agency and two of the

best known banking institutions in the country; one eastern and one southern. Our arrangements are based on a policy of consistent selling, and our marketing methods have the unqualified approval of each of these three institutions.

Improvement over old method.

It may be asked, in view of all that I have said, " In what respect, then, is the Staple Association's system an improvement over the old method, in so far as the planter is concerned ? " The question is a fair one, and I shall conclude this discussion with a reply. In the first place the Association does receive a better average price for its cotton than is received for the average outside. This simply means that our policy of consistent, steady selling, day in and day out, month by month, throughout the season, secures better average returns than come from selling by fits and starts, spasmodically and unsystematically. We are justified in this conclusion, not only by our private advices and information, but by comparing our prices with those reported for our territory by the Bureau of Markets. A recent issue of a leading New England journal spoke of the large number of odd lots of fifty to two hundred sales of staples which were being picked up here and there at cents a pound under Association prices. This is absolutely legitimate trading, but we do not sell our cotton that way. All such sales unfavourably affect the average outside price while being of doubtful value as purchases to anyone except the individual buyer who made the pick-up.

Another important service to the grower, without cost to anybody, is rendered through the Association's financial arrangements. The Association supplements the aid of the local bank, to the end that " distressed cotton " is a thing of the past, in so far as our members are concerned.

Under the old system the grower has always felt that he had a just ground of complaint in the matter of samples and loose. He has felt that his cotton was unfairly dealt with, that it was sampled more than was necessary, that too much loose was accumulated from it, and that the whole process was wasteful and unjust. From time

immemorial he has been assured that his complaint was groundless, or at least that he greatly exaggerated the results of these practices. During the Staple Association's first season it received 157,865 bales of cotton. Every effort was made to reduce waste to a minimum, and each bale was sampled but one time. Yet the accumulated samples and loose from our cotton, handled in this way, amounted to 256 bales. It would be interesting to know just what the aggregate loss to the grower amounts to on the entire American crop, on this one item alone. For it must be borne in mind that every penny of the savings on the various items which I have mentioned represents, or is equivalent to, a loss to the grower under any other system. Let me give you one other illustration, before I close. The Association makes an expense deduction, in selling the cotton of its members, of three per cent. of the sales price. When we began operations it was predicted by our friends outside that we would never operate under this, but would have to make additional deductions or assessments. We are reputed to have the best-paid cotton men in America at the head of our sales department. Possibly this is true. We are charged with having an expensively organized business. This is not true. But be this as it may, at the close of our first season's operations, instead of calling on our members for additional expense money, we refunded to them in cash nearly $300,000, an amount equivalent to exactly one-half of our original three per cent. deduction.

The man, therefore, who imagines that our success depends upon the elimination of middlemen, or that the only saving to the grower which such an organization can accomplish is the middleman's profit, knows very little about the inner operations of the Staple Cotton Association. We are not trying to eliminate the middleman. On the contrary, we like him, and do business with him every day.

Notes

THE BOARD OF AGRICULTURE IN INDIA.

THE Thirteenth Meeting of the Board of Agriculture in India will be held at Bangalore from the 21st to the 26th January, 1924, when the following subjects will be discussed :—

(1) To review the progress made in non-credit agricultural co-operation in India and to consider ways and means of stimulating further progress.

(2) To examine the curriculum of the Imperial Institute of Animal Husbandry and Dairying at Bangalore and to consider the best means of co-operating with Provincial Governments and Indian States with a view to utilizing this Institute to the best advantage.

(3) To consider the best means of utilizing the Pusa, Bangalore, Wellington and Karnal dairy and cattle-breeding farms for the good of India as a whole.

(4) To review the steps being taken by Provincial Governments and Indian States for the improvement of cattle by better breeding and feeding and to make recommendations.

(5) To consider the steps taken to give effect to the recommendations of the Board of Agriculture of 1919 (Subject IV) for the improvement of—

(*a*) forecasts,

(*b*) final statistics of the area and yield of cotton in India.

(6) To consider the progress made in giving effect to the recommendations of the Indian Cotton Committee for 1917-18 with special reference to—

(*a*) the work of the Central Cotton Committee,

(b) the recommendations of the Board of Agriculture of 1919 in regard to cotton marketing.

(7) Is it possible and desirable to make Government farms, including experimental, cattle-breeding, seed and demonstration farms, pay ?

(8) To review the progress made in popularising the use of improved agricultural implements and power machinery in India with special reference to—

(a) the provision of facilities for sale, hire and repair,

(b) propaganda,

(c) the designing and testing of implements.

(9) The utilization of indigenous supplies of phosphates.

(10) To consider the steps taken to give effect to the recommendations of the Indian Sugar Committee with special reference to those relating to the Coimbatore Cane-breeding Station.

(11) The desirability of bringing waste lands under cultivation with a view to increasing the production of food grains.

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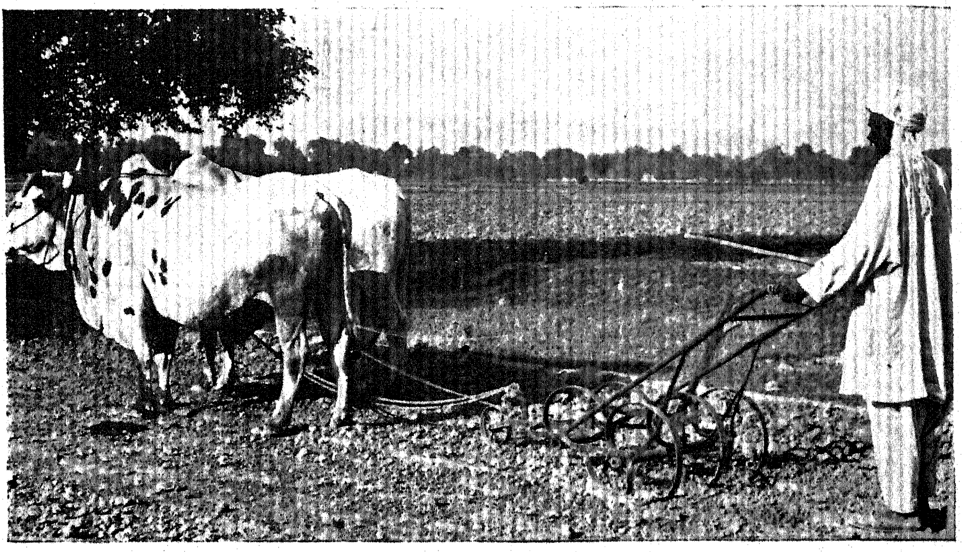
A NEW SPRING-TOOTH HARROW.

Of the steel agricultural implements which have been introduced to India in the past 15 years, the spring-tooth harrow is perhaps one of the most popular. At the Peshawar Agricultural Station it is the most useful implement next to the Rajah plough. After the land has been turned over, planked and rolled, the five-tooth harrow drawn by a pair of good oxen is used in place of the country plough, and it satisfactorily treats four times as much land as the latter implement in a day's work. In the orchard the harrow is also useful ; but as it cannot be controlled and directed by the ploughman, it is liable to bark the trees.

A new five-tooth-spring-tined harrow has recently been imported from Australia which has stilts and a guiding fore-wheel. This implement can be controlled and directed with ease and accuracy,

and it may even be used to intercultivate crops which are planted in lines 3 to 4 feet asunder. On fallow land the implement does as much work and does this as efficiently as the old type of harrow. At the same time it is far lighter in draught than the spring-tooth harrow which has neither stilts nor fore-wheel.



The Nobelius spring-tooth cultivator.

Without any real exertion the ploughman can lighten the draught to the oxen on difficult patches of land and turn the harrow with ease on the head-lands. Altogether the implement which is called the Nobelius cultivator is a distinct improvement on the old spring-tined harrow. [W. ROBERTSON BROWN.]

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ROOT PRUNING OF THE MANGO PLANT.

IT is generally believed that the mango plant does not bear root pruning which, if performed, either kills it or makes its growth stunted. This might be true in the case of big trees, but from my own experience I can say that mango seedlings from two to three years of age withstand close root pruning as any other plant generally does. I have seen little difference between the growth made by a pot grown plant transplanted to the field with all its cramped and tangled roots and that made by a plant raised on

the ground and subsequently transferred to another place after close root pruning.

It is an undoubted advantage that the mango grown *in situ* has a very deep reaching tap root and makes a vast spread. It does not require much irrigation. But in every case it is not very convenient to grow plants *in situ*, especially when one requires grafted plants for the garden. In such circumstances there does not appear to be much good in propagating seedlings in pots where they do not make a fair growth. The stock is unnecessarily dwarfed.

It was in the beginning of the monsoon of the year 1918 that I wanted some mango grafts for my own garden. I decided to take the grafts from the trees belonging to a relative of mine living at 20 miles from my place. I had mango seedlings two to three years old. To my great annoyance I found that my *mali* had not moved these seedlings during the period of their growth on the spot where they had been planted while only two or three weeks old. So from two to three years they had been left in the same position without being disturbed. When a few plants were taken out, the tap root was found to have gone deeper than a foot or 18 inches. These plants had to be taken out with a big quantity of earth and any attempt to accommodate them in medium sized pots involved extensive root pruning and the attendant risk of killing the plants outright. No young seedlings were available in the vicinity. I had to hasten the despatch of plants as the roads were *kacha* and heavy rains would have made it extremely difficult for the bullock cart to move.

What I did was to put the plants in pots after pruning away much of their roots. Then their leaves and young shoots were clipped off—two or three leaves being left on each plant. The plants were kept in a dark and cool place where there was enough ventilation. For three or four days water was sprinkled over the plants thrice a day. This moistening was slowly stopped and the plants were gradually made accustomed to exposure. On the tenth day they were able to bear the midday sun of the month of July. They were despatched for grafting on the fifteenth day. Out of 56 seedlings thus taken out 45 survived.

Enarch-grafting was done on all the plants. A single matured shoot was used as the scion in each case.

Just after a month I had to meet another obstacle. The parent mango trees were only a few furlongs away from the Ganges. Floods threatened, and as all the seedlings in the pots were on the ground, the grafts had to be removed early to avoid submersion.

As was expected, some of the scions showed signs of withering only after a few hours of their removal from the parent trees. Their leaves were reduced to two or three only and they were given the same treatment as the seedling stocks had received after removal from the ground to the pots. In 10 days fresh buds appeared on the scions and they were gradually made accustomed to the full exposure of the sun. This took another 10 days. Then they were taken back to my garden where they were planted on the third day of their arrival.

Grafting was performed on 45 plants of which only 32 survived. The dead plants were examined and the failure was mostly due to the rain water having found its way through the grafting clay. The cut surfaces were infested with fungoids and ants.

Of these 32 grafts, I have at present 27 trees alive. They have made as much growth as pot grown grafts. Both have been equally irrigated. It is too early to determine anything further about the two classes of grafted trees. There seems to be no difference in their fruiting capacity.

Subsequently I have found that the loss can be minimised to a very great extent with some care and patience.

The advantages of this method are :—

(1) The pot grown plants are stunted and require constant supply of water and care. The stock grown on the ground makes a full growth and requires less care and watering. The stock from the pot grown plant is not very strong and robust.

(2) When transferring a pot grown plant to the ground, one has to plant it with all its injured and cramped roots. The plants which have their roots pruned make a

fresh growth of roots and restart growing with a new vigour.

(3) The whole time required for preparing a graft fit for plantation is only about nine weeks, and during this short period one gets quite a big and hardy grafted mango plant. Under the ordinary system the time and labour required are unnecessarily long and heavy. [RAJ KISHORE SINGH.]

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CAUSE AND CONTROL OF FIJI DISEASE OF SUGARCANE.

FIJI disease has long been listed as one of the diseases the cause of which is unknown. Recent work done in the Department of Plant Pathology, at the College of Agriculture, Los Banos,[1] has demonstrated a very probable cause. Since the paper describing the cause is very technical, this article is now being presented to make the results more available to the sugar-growing public.

Any one familiar with Fiji disease in the field knows that the character by which it may be certainly recognized is the presence of galls on the leaves. These galls are generally hard, raised places along the veins which appear as tiny, raised, white spots on the young leaves and as yellow or brown ones on the old leaves. They distinguish Fiji disease from all other diseases of cane. Insect and fungus pests produce galls in many plants. In such cases the pest—fungus or insect—lives in the galls, so in the case of Fiji diseased cane one would naturally search in the galls for the cause of the disease.

The galls are composed of cells like those making up the pith of the cane except that the gall cells have thickened walls. Every typical plant cell contains a central body called the nucleus and a liquid in which float the food making and storing organs of the cell. With a good microscope one can see in cells of Fiji galls bodies which are not present in ordinary plant cells or in the cells of healthy cane. These bodies, when taken out of the gall cells and placed in cane

[1] McWhorter, F. P. The nature of the organism found in Fiji galls of sugarcane. *Phili. Agri.*, XI, 103-111, 1922.

juice, will liven up and develop at once into active organisms known as amœbæ, thereby showing that they are not merely some inert substance present in the cells and developed by the disease, but foreign organisms living in the cane cells. A study of their life-history showed them to be amœbæ and that the stage common in old gall cells was the resting stage known as cysts. Amœbæ are small, single-celled animals that are able to move from place to place by means of jelly-like protrusions from their own bodies. Whereas these amœbæ are entirely absent in healthy cane and are most abundant in the gall cells of Fiji diseased cane, it is thought that they are the cause of Fiji disease. It is hoped that work, which is now in progress at the College, will conclusively demonstrate whether or not this is actually the case. Amœbæ cause many animal diseases, notably dysentery in man, but most plant diseases are due either to bacteria or fungi. The amœba thought to cause Fiji disease is so small that it must be magnified several hundred times to make it visible, but it is much larger than disease causing bacteria; it would take about 50 bacteria to equal one medium-sized Fiji amœba.

It is generally thought among sugar men that Fiji disease is not carried through the soil; hence it is considered safe to plant cane after cane in a Fiji infested field. The writer has demonstrated the amœbæ in the roots of badly diseased cane, and therefore wonders if some of the disease generally attributed to bad seed and probably insect transmission is not due after all to soil transmission.

The work of Lee and others has very definitely proved that the planting of sets from diseased cane is certain to give rise to diseased cane. Those wishing an excellent statement of this fact should read Lee's article in the "Plant pest and disease number" of the *Philippine Agricultural Review* for 1922. Also we have demonstrated this fact several times here in our experimental plots. The fact that healthy sets must be planted in order to get healthy plants must be the starting point in controlling the disease. To this generally accepted fact the writer wished to add another, which he feels his experience during the past year more than justifies.

Namely, *it is unsafe to select sets from any part of a field if Fiji is present in the field.* That is, it is dangerous to select sets from apparently healthy plants in a field wherein the disease is occurring. This is especially dangerous if the sets are being taken from ratoon stands. The disease may be latent in the old cane and appear at once in the seedling.

Another thing that we have recently demonstrated at the College is the effect of excess water on diseased plants. Plants which had almost died of the disease when growing in field conditions frequently took on new growth and almost recovered when transplanted to saturated soil. Perhaps irrigation will render plants less susceptible to the disease.

Certain varieties of cane are unquestionably less susceptible to the disease than others. The writer does not believe sufficient careful experimental or field work has been done on this subject to, as yet, justify any definite statement as to what are the resistant Philippine varieties.

In regard to controlling the disease it cannot be too strongly emphasized that one should plant healthy sets taken from field *in which there is no Fiji disease.* [FRANK P. MCWHORTER in *Sugar News*, IV, No. 8.]

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NEED FOR FRESH COTTON FIELDS.

AN instructive lecture was delivered at the Textile Institute, Manchester, by Mr. Walter R. Dunlop, Professor of Economics at the West Indian Agricultural College, on "Cotton and some of its Problems." Mr. Myers, Chairman of the Lancashire Section of the Institute, occupied the chair.

The lecturer, in giving a brief history of the cotton supply in this country, said the enormous industry of this country and the world was essentially a nineteenth century development, extending from the French Revolution in 1798 to the outbreak of the European War in 1914. Up to the French Revolution France was the coming cotton country, but the Revolution brought as its material penalty a set-back to French industrialism, which took at least ten years to recover. Britain diverted the supply of cotton to this country.

Regarding the present position of world production and consumption, Professor Dunlop said that during the last 25 years the consumption had been increasing at a greater rate than production. It was due to the increasing manufacturing demand of the United States, Canada, Japan and India, and to a reduction in the acreage yield in America and Egypt. The decrease in Egypt per feddan had been due to poorer lands being brought under cultivation, bad drainage, and insect pests like the pink boll-worm, the latter being the main factor. In the United States during the last ten years it was due to the spread of the boll-weevil and labour shortage. In new areas the pink boll-worm was the most serious insect pest. The boll-weevil was confined entirely to America, whereas the pink boll-worm was world-wide in its distribution.

Discussing the United States crop, the lecturer said that perhaps the most serious feature was the tendency to violent fluctuations due to the reaction of prices on area planted, the weather damage during prolonged picking periods, and the notoriously speculative character of the crop. Mixed farming also made regulation of the cotton area economically easy, while high labour costs did not make it attractive or even possible at pre-war prices. Furthermore, conditions in the United States were not conducive to the preservation of uniformity and of quality—a very important matter for Lancashire. There had been deterioration in quality as well as quantity due to longer picking periods, inefficient baling and compressing, and insect pests. To indicate the immediate position, in the season 1921-22 the world's crop was 15 million bales and the world's consumption nearly 21¼ milion bales, of which nearly 13 million bales was consumed in the United States. This implied the absorption of the carry-over, or post-seasonal stock, and was obviously serious. The position at present was that trade would not revive sufficiently to make the supply of cotton a serious matter for some years. The present need for expanding and stabilizing the production of cotton in the near future was obvious, and it was a matter the urgency of which had long been recognized. The work of the British Cotton Growing Association had led to excellent results, and it was also being taken up by the Empire

Cotton Growing Corporation with the assistance of the spinners, and they would by means of the Corporation be able to provide more scientifically trained men in new areas. The Sudan, India, East and West Africa and Queensland were being given increasing opportunities to expand.

The department with which he had been connected in the West Indies had tried to re-establish Sea Islands cotton round about 1897, and it took many years, with great difficulty and perseverance, before that industry could be properly established. Now, through lack of demand for finer cottons, the existence of the industry was jeopardized. They had to be very careful or it might deteriorate, and possibly disappear.

The expansion of cotton into new regions of the empire was no easy task. This was a matter which might not interest them directly, but he thought it was extremely advisable for people in Lancashire to be familiar with what was happening and what they were trying to do at the production end. It was evident in regard to these problems the difficulties which would arise were temperature, water, labour, supply, transport and finance. It was to be hoped that no scheme would be attempted unless these matters were present and could be provided for. They were obviously essential in these regions and demanded the employment of men of ability.

In regard to pests in new areas, from the standpoint of American production the boll-weevil was by far the most serious pest; but it was the pink boll-worm which was the most menacing pest in new areas. The distribution of the pink boll-worm gave cause for considerable anxiety, but the boll-weevil was entirely confined to the United States and tropical America, whereas the pink boll-worm had a world distribution, which was an important point in regard to sending cotton into new areas.

The development of cotton in new areas required a study of human nature, economic subjects in general, as well as a study of natural scientific conditions. Cotton was grown by coloured labour largely. At present, as Mr. Himbury showed, cotton cultivation was between 17 degrees north of the equator and 15 degrees south, and the production of cotton would not only be largely dependent

on coloured labour but also on coloured management. All this meant that scientific organization and study of man in relation to cotton would be as necessary as the study of cotton in relation to man.

In developing the empire's cotton fields in the future it would be necessary to have economic research. By economic research he meant investigation into the problems and difficulties along lines that came under the studies of the various schools of economics and conducted along practical lines, and accurate costing would be necessary. The study of marketing was very important in other forms of raw material. He was advocating industrializing cotton, to put it on the same organized scale as the intermediate manufacturing industries through which the raw material went before it reached the consumer in the form of goods. It required broad thinking. From the spinner, even from the consumer, to the cotton grower there must be one continuous line of organized contact—a cotton industry to embrace production, manufacture, and distribution. Research and ingenuity in this country must be unremittingly applied to keep up and extend the demand.

At the growers' end psycho-economic science, as well as natural science, would be wanted. The conception of tropical labour as a herd of human energy to be exploited was archaic. A feature of cotton growing was that it was increasingly becoming the occupation of the smaller peasant proprietors. In any case, even with ordinary wage earners, motion studies, reduction of fatigue and possibly vocational selection were necessary. The object was to save time, reduce fatigue, strengthen efficiency and lessen the cost of production. These were only some of the possible applications of psycho-economics. One could mention further the statistical (mathematical) study of the cost of living, market prices of cotton and production costs in different countries and the complex and important problems of price reactions on production in different areas. Accurate costing was essential, especially when there was rotation of crops, and systematised methods should be introduced in order to avoid, for instance, the inclusion of interest on capital as a costing charge as had been done recently in Texas. Accurate

costing could be done. It had been done by the rubber industry, which produced perhaps the best costing figures of any industry growing raw material in tropical countries. On the other hand, in certain districts where cotton was grown in rotation with other crops, he did not think any one really knew the cost of its production.

But in the long run the ultimate success of establishing new and large areas would depend upon a rational combination of interests. There ought to be closer economic contact between the manufacturing and the producing end. If the new areas were to be established, it was up to manufacturers, spinners and even consumers to do what they could to stabilize prices and stimulate the demand, especially for the finer kinds. A good example of the tendency to organize an industry right through from the production of the raw material to the manufacturing was seen in connection with rubber. Something like the general organization that was there being attempted should be done in relation to cotton. If some of the lines of development he had suggested were followed, by the end of the twentieth century the supply of cotton would be satisfactory, and the industry as a whole would be not merely one of the greatest imperial industries but one of the greatest of imperial achievements. [*The Textile Mercury*, XVIII, No. 1786.]

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CEARA COTTON.

CEARA is a State situated in the north-eastern portion of Brazil covering an area of 160,987 sq. km. (almost the size of Italy) which has produced cotton for many years, though the quantity grown has so far been on a small scale, some 150,000 bales of 300 lb. every year, but extensive irrigation works which are in course of construction promise to make Ceara a regular supplier of medium staple cotton ($1\frac{1}{8}$ to $1\frac{3}{8}$ in.) of some importance. Some parts of the State are indeed able to grow long staple cotton. The main reason why Ceara cotton is sold in Europe below the price of similar cotton is that the cultivators have hitherto grown four or five different kinds of seeds in one and the same field and have paid little attention to the grade; unfortunately the export merchants have not

sufficiently encouraged the few who sold them a uniform and clean cotton.

This state of affairs is now being remedied. On the strength of recommendations made by the writer to the Government of the State of Ceara and to the Federal Government three large cotton seed farms are being established as a start in the principal districts, where only one variety of seed will be grown, so that a mixture of various strains will finally become next to impossible. In most of the districts tree cottons are planted, though in some parts which are subject to floods the annual American kind is grown.

The merchants of Ceara are also organizing themselves to bring about a more up-to-date method of handling cotton. [A. S. PEARSE in *Int. Cotton Bull.*, No. 3, 1923.]

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COTTON RESEARCH.

THROUGH the courtesy of the British Cotton Industry Research Association, the Secretary of the Indian Central Cotton Committee has sent the following abstracts for publication :—

MICROMETRIC SLIDE RULE.

A nomograph is engraved on a xylonite strip by means of which microscopic measurements can be obtained with any combination of objective, eyepiece, etc., after a single calibration. A second nomograph on the back permits of making corrections for alterations in the length of the microscope tube. [*Jour. Roy. Micro. Soc.*, 1923, pp. 57–61. H. J. DENHAM.]

SPINNING TEST OF AMERICAN COTTON.

Comparative spinning tests of the following cottons from the crop of 1921, grown under boll-weevil conditions, have been made : Acala, Lone Star, Mexican Big Boll, Rowden, and a typical cotton of the kind commercially known as " North Georgia." All the cottons were tested under identical mechanical conditions. The grades, lengths of staple, percentages of visible waste, strength of the yarns and percentages of average deviation or irregularity of the sizings and strengths indicate that for hard twisted or warp

yarns the varieties tested, if placed in order of their merit from a spinner's point of view, would fall as follows: (1) Acala and Mexican Big Boll, equal; (2) Lone Star and Rowden, equal; (3) Typical North Georgia. [*U. S. Dept. Agri. Bull.* 1148, 1923, 6 pp. W. R. MEADOWS.]

COTTON STAPLE TEST.

Several new methods of obtaining mean staple lengths and staple diagrams are described: (1) This method is practically the same as that of the Baer sorter. (2) A sliver, in which the hairs are thoroughly mixed and parallel to one another, is gripped along a line perpendicular to its length. The loose hairs are combed out and the sliver cut along the line of grip. The tuft so obtained is weighed. It is shown (on the assumption that the mass of a hair is on the average proportional to its length) that the mean staple length is 2 N. c.g.; where N.c.=the length per unit mass of the sliver and g.=the mass of the tuft. (3) A sliver is gripped as in (2) and the loose hairs combed out on both sides of the grip. The hairs remaining are rearranged so that the extremities of the hairs are in line. The thickness of this tuft is measured at different positions along its length, by means of an apparatus described in the paper. (4) The procedure is the same as (3) except that the hairs in the tuft are not rearranged, and only one side of the tuft is used. (5) The same as (4); but instead of measuring the thickness of the tuft, the tuft is cut into sections, which are afterwards weighed. Several methods are given for reducing the results of (3), (4) and (5) to the ordinary staple diagram, and for obtaining the mean staple length. [*L'Ind. Text.*, 1923, **39**, 156–162. H. FLUHR.]

FIELD PLOTS.

The control of experimental error in nursery trials has been studied and it is shown that the yielding ability of selections or crosses as grown in small individually planted plots is of little value as an indication of the comparative yielding ability of the separate selections. The rod-row method is in general use as a means of obtaining preliminary yielding tests of new plant breeding

productions. As a result of field experiments it appears that three row plots, each row being approximately 16 ft. in length, and the use of only the central row in the yield test is a desirable plan. Replication, in general, reduces the probable error according to mathematical expectation. Four systematically distributed plots are suggested for each variety in the trial. The probable error may be calculated from the deviation from the mean of the variety method. It has about the same relative magnitude as that obtained from computing the probable error from the check plot method. If the test in rod row trials is conducted properly the use of the calculated probable error, as a means of determining the reliability or significance of any particular strain comparison, is justified both from the mathematical and practical standpoints. [*Jour. Amer. Soc. Agronomy*, 1923, **15**, 177–192. H. K. HAYES.]

The following are the results of a study of replication in relation to accuracy in comparative crop tests. In all the tests made large plots were found to be more accurate than small plots. The mean percentage ranged from 2·31 with wheat plots 0·032 acre in size to 7·86 with oat plots 0·0016 acre in size. An increase in the length of plot has greater influence on decreasing the error than has an increase in width. Replication is much more effective in reducing error than is a change in either the size or shape of plots. If land is limited the frequent replication of small plots is a more efficient means of obtaining a high degree of accuracy than is the use of the same amount of land with less frequently replicated larger plots. Within the limits of the size and shapes of plots, and number of replications used in the experiments described it does not seem possible to reduce the probable error below 2 per cent. and to measure differences in yield of less than 6 per cent. with certainty unless eight to sixteen replications are made. [*Jour. Amer. Soc. Agronomy*, 1923, **15**, 192–199. R. SUMMERBY.]

HISTORICAL ACCOUNT OF COTTON.

References to the early literature regarding cotton are given from the inscriptions of Senacherib and Theophrastus. Philological

evidence is presented that cotton originated in Assyria and India and that it was not introduced into Egypt or Europe until the Arabic conquest. The author regards the statements in Pliny, other than those copied from Theophrastus, as largely interpolations of a much later date. The author suggests that if the accounts of Columbus and the early explorers are correct, *Bombax ceiba* rather than *Gossypium* was the plant meant by " cotton." Since Columbus brought seeds of a number of plants on his second voyage, it is probable that he imported cotton, a crop perhaps new to the Indians since they were so reluctant to cultivate it. Most of the native cloth was made from the maguey. Cotton culture in Mexico is discussed in detail with a survey of all available references in 16th century literature. With regard to Peru, it is suggested that cotton was introduced at the conquest by the negro overseers. Evidence is given that the presence of cotton in graves is no safe criterion of its antiquity. [*Bot Abstr.*, 1923, **12**, 268; from " Africa and the Discovery of America," Vol. II, 1922. L. WIENER.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

MR. GIRJA SHANKER BAJPAI, C.B.E., I.C.S. (United Provinces), has been appointed Under Secretary to the Government of India in the Department of Education, Health and Lands from 3rd September, 1923.

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MR. D. BALAKRISHNA MURTI, on return from leave, has been posted as Professor of Agriculture and Superintendent, Central Farm, Coimbatore.

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MR. P. H. RAMA REDDI, M.A., B.Sc., on relief by Mr. D. Balakrishna Murti, has been appointed Deputy Director of Agriculture, III Circle, Madras.

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MR. D. A. D. AITCHISON, M.R.C.V.S., Principal, Madras Veterinary College, has been placed in charge of the current duties of the office of the Chief Superintendent, Civil Veterinary Department, Madras, in addition to his own duties, during the absence of Mr. F. Ware on combined leave for one year from 1st October, 1923.

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MR. T. F. MAIN, B.Sc., Deputy Director of Agriculture, Sind, has been granted combined leave for ten months from the date of relief by Mr. T. Gilbert.

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MR. ABDUL RAHMAN MALIK has been appointed to act as Deputy Director of Agriculture, Eastern Circle, Bengal, from 21st July, 1923, *vice* Mr. K. McLean appointed to officiate as Fibre Expert to the Government of Bengal.

Mr. H. W. Stewart, Agricultural Engineer, Bihar and Orissa, has been granted leave on average pay for nine days from 26th October, 1923.

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Captain P. B. Riley, Deputy Director, North Bihar Range, has been confirmed in his appointment in the Indian Veterinary Service from 21st March, 1923.

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Dr. H. M. Leake, M.A., Sc.D., Director of Agriculture, United Provinces, has been placed temporarily on foreign service under the Government of the Sudan, from 9th October, 1923, or subsequent date.

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The services of Mr. O. T. Faulkner, B.A., Deputy Director of Agriculture, Punjab, have been transferred permanently to the Nigerian Service from 15th June, 1921.

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Mr. T. A. Miller Brownlie, Agricultural Engineer to Government, Lyallpur, has been appointed to officiate as Principal, Punjab Agricultural College, *vice* Mr. D. Milne, acting as Director of Agriculture, Punjab.

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Rai Sahib Lala Jai Chand Luthra has been promoted to the Indian Agricultural Service and appointed Associate Professor of Botany, Punjab Agricultural College, Lyallpur, from 27th August, 1923.

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Having finished his work in the Punjab Irrigation Department, Sardar Sahib Kharak Singh, M.A., resumed charge of his duties as Associate Professor of Agriculture in the Punjab Agricultural College, Lyallpur, on 19th July, 1923.

MR. T. J. EGAN, M.R.C.V.S., Assistant Superintendent Government Cattle Farm, Hissar, was on one month's leave on average pay from 24th August, 1923.

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THE services of MR. R. T. PEARL, B.Sc., A.R.C.S., as Mycologist to the Government of Central Provinces will terminate after 30th November, 1923, on the expiry of the combined leave granted to him.

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MR. S. T. D. WALLACE, V.C., B.Sc., Officiating Deputy Director of Agriculture in charge of Animal Husbandry, Central Provinces, has been confirmed in his appointment in the Indian Agricultural Service from 25th April, 1923.

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MR. C. W. WILSON, M.R.C.V.S., Superintendent, Civil Veterinary Department and Veterinary Adviser to Government, Central Provinces, has been granted combined leave for one year from 1st November, 1923, Mr. R. F. Stirling officiating.

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MR. LESLIE LORD, B.A., Deputy Director of Agriculture, Northern Circle, Burma, has been granted leave on average pay for seven months from 9th September, 1923.

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MR. W. GREGSON, Deputy Director of Agriculture, Burma, has been transferred from Myingyan and posted to duty with headquarters at Mandalay from 1st September, 1923.

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CAPTAIN A. O'NEILL, Civil Veterinary Department, Burma the termination of whose services has been sanctioned by the Secretary of State for India, was relieved of his duties on 2nd July, 1923.

Reviews

The Science and Practice of Coconut Cultivation.—By H. C. SAMPSON, C.I.E., B.Sc. (London : John Bale Sons and Danielsson, Ltd.) Price, 31*s*. 6*d*.

MR. SAMPSON's long expected book on the coconut palm has been published, and it is a valuable addition to the scanty literature that exists on this important commercial crop. The coconut palm is cultivated largely on the West Coast of India, and especially in the Native States of Travancore and Cochin and in the Malabar District of the Madras Presidency. Mr. Sampson's connection with the Madras Agricultural Department, first as Deputy Director and later on as Director of Agriculture, gave him ample opportunity to study the problems connected with coconut cultivation. He collected a mass of useful information about local practices and methods and conducted his own experiments and investigations at the coconut stations recently started by the Madras Agricultural Department. All this information and results of his experiments and investigations are embodied in the book under review. It is divided into three parts: the first dealing with the morphology of the coconut palm, the second with the planting and management of the plantation, and the third with the manufacture of coconut products.

The most important chapter in Part I is that which deals with the root system. The study of the root system of the coconut palm has been neglected so far, and it is very creditable that Mr. Sampson recognized the importance of this subject and made a careful and detailed study of it. The effect of drainage and aeration of soil on the development of roots and the necessity for the removal of the dead rootlets and for the maintenance of a soil mulch by frequent cultivation have been well brought out by the author. It is a common belief among cultivators that the seed

nuts from trees growing on the seacoast should not be used for planting in the interior parts. Mr. Sampson gives a rational explanation for this belief on page 3 of his book. He says: "Some trees will send their roots obliquely into the soil, while in others the greater number of roots will grow in a much more horizontal direction. In all probability it is for this reason that the practice has arisen to obtain seed nuts from trees grown under similar soil conditions to those on the area required to be planted up." The variations in the root system caused by good or bad drainage, the influence of the permanent stagnant water table on the growth and productiveness of the tree, the difference between "feeding roots" which grow more or less horizontally on the surface, and the "water roots" which grow downwards till they reach the water table, the drought resisting power and the high yielding capacity of trees with deep water roots, these and other observations based on a study of the root system will prove highly beneficial to any practical coconut cultivator.

In the remaining chapters of Part I, the author describes the stem, the crown, the leaf, the flower, the fruit, the germination of the seed and the development of the seedlings. The description is interesting from the scientific and the practical point of view. The hints contained in these chapters for the identification of good trees from which seed nuts are to be selected are of special interest to all prospective coconut cultivators. A regular and heavy yielding tree can be recognized from the leaf scars on the stem, which will be deep and close together. Again, the crown of such a tree will be compact, the leaves being close together, and it may contain as many as 35 to 40 leaves. The leaf-stalks should be short and thick with wide leaflets. Trees having long and slender leaf-stalks with narrow leaflets should be avoided. The fruit stalks should similarly be short and thick. Seed nuts selected from such trees are the best for planting. Proper attention is not being paid to these points at present. It must be remembered that the coconut is a long standing tree. Its age may go up to 100 years and more under favourable conditions. The evil effect of any mistake made in the selection of the seed nut will last throughout the life-time

of the tree, and hence the importance of bestowing the greatest care on the selection of seed nuts cannot sufficiently be emphasized.

In Part II which deals with the planting of coconut seedlings and the subsequent management of the plantation, the author makes many useful suggestions in regard to the selection of the site, the quality of the land suited to coconut cultivation, the raising of seedlings in the nursery, the method of planting and the distance at which seedlings are to be planted, the application of manure, the cultivation of cover crops, etc. In regard to the method of planting the author deprecates deep planting which is practised on the Malabar Coast. Deep planting is not practised on all kinds of soils. Only on elevated laterite lands exposed to the wind is this practice adopted, and from general experience it is found that on such lands deep planting has distinct advantages.

In Part II the chapter which should attract the prominent attention of the reader is the one dealing with manuring. From the numerous analyses of the different parts of the tree conducted at different stages, which are given in tabular forms in this chapter, one can easily find out the food requirements of the tree at each stage and adopt a rational and economic system of manuring suited to such requirements. Coconut is a crop which responds readily to the application of manure. Trees which yield on an average 25 or 30 nuts per annum can be made to yield double that number and even more by a proper system of manuring. At present very little manuring is being done on the Malabar Coast, and the little that is done is not based on any scientific principle. There is considerable scope, therefore, for the development and improvement of the method of manuring. Mr. Sampson has only touched upon the fringe of this complicated problem of manuring the coconut palm, but he has opened out the way for further investigations and experiments and indicated the lines along which the work should be carried on. This in itself is of great value.

Part III deals with the manufacture of copra, coconut oil and other products. The ordinary methods that are practised in coconut growing areas are described and they do not call for any special remarks.

One noticeable drawback of the book is the absence of a chapter dealing with diseases and pests. Coconut is subject to the attack of very many serious diseases and pests and a great deal of original work has been done on them in Ceylon. The Rhinoceros beetle, the Red weevil and *Nephantis serinopa* are some of the serious pests, and the root disease, the bud-rot and the stem bleeding disease are the most important fungoid diseases of the coconut palm on the Malabar Coast. A description of these pests and diseases and of the remedial and preventive measures so far known, would have added considerably to the usefulness of the book. It should also be noted with regret that the question of the nut fall has not been fully dealt with in the book. Nut fall may be caused by the attack of fungus, or by the non-fertilization of ovules or by alterations in the physiological condition of the tree brought about by water stagnation in the soil and defective aeration. Practical coconut cultivators would have welcomed a description of these causes, the circumstances under which they occur and the measures to be adopted for remedying them.

In spite of these drawbacks which, it is hoped, will be removed in a subsequent edition, the book on the whole is a creditable production, and it should find a place in the home of every present and prospective cultivator of the *Kalpa Vriksham* (The Tree of Life) of Kerala. [N. K. P.]

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Kalide Murghi Khana (in Urdu) : Key to Poultry Keeping.— By TAHIR H. QURASHY, B.Sc., Late Farm Manager, U. P. Poultry Association. Pp. 258. Illustrated. Price, Rs. 3.

THE activities of the U. P. Poultry Association, under the able guidance of Mrs. A. K. Fawkes, have created wide interest in poultry breeding in Northern India, and the publication of this manual will to some extent meet the requirements of a large class of people to whom books written in English are of little use. It is planned on a more ambitious scale than Mrs. Fawkes' brochure on "Murghion ka rakh-rakhaw" and deals briefly but adequately with all aspects of poultry keeping, but it cannot

be said that the author has succeeded in making clear the principles of Mendelism to the class of readers for which it is intended. In chapters dealing with the selection and breeding of fowls, housing and feeding, the author has assimilated the valuable experience gained by him at the Lucknow model farm, and the instructions given should prove of great benefit both to the professional who rears poultry for the market and the amateur who keeps fowls for domestic consumption. Many country medicines have been mentioned in the chapter on treatment of diseases, and some of them are no doubt both economical and beneficial. [S. M. J.]

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The Cotton-growing Countries: Production and Trade.—Compiled by MR. JOHN HUBBOCK, Agent Technique of the Statistical Bureau of the International Institute of Agriculture, Rome, 1922. (John Heywood, Ltd., 121, Deansgate, Manchester; 20–22, St. Bride Street, London, E. C. 4.) Price, *5s.*

THIS monograph is an inventory of the world's cotton crops made up from various earlier publications on the subject and brought up to date from the results of a questionnaire sent to the governments of the known cotton-growing countries in 1921. The ground covered is wider than in any previous publication, though cropping details in many localities are somewhat scanty.

It is a decided step forward towards the attainment of a complete statistical picture of the world's cotton crops. The opportunity to tap the widest possible sources of information, such as is provided to the compiler in the International Institute of Agriculture, has been well used and the conciseness and methodical arrangement of material makes this small volume an invaluable means of reference for all those interested in cotton production.

A special feature is the large measure of success that has accompanied the effort to give, in analysis, as great detail of acreage under cotton, total yield and yield per acre, for the world at large, as has already been done for the American, Egyptian and Indian crops in particular. Differentiation between the production of

long and short staple cotton in the various countries is also emphasized.

Whilst this is probably the most comprehensive survey of its kind, it shows quite frankly the gaps that must be filled before the measure of the world's ability to increase its production of cotton can be remotely measured. The volume is important in indicating the vast extent of the unknown as well as the known factors. With China's cotton crop figures too uncertain to be included, the possibilities of Central Africa, N. and S. of the Equator, and of the depths of Brazil are only hinted at.

Tables on pages 132–142 give interesting figures of cotton exports from 93 countries and imports into 84 countries. The last five pages give cotton prices from 1912-1921 of Middling American in New Orleans, f. g. f. Sakel in Alexandria and G. O., M. and M. F. in Liverpool. [*The British Cotton Industry Research Association*, Vol. III, No. 4.]

NEW BOOKS
ON AGRICULTURE AND ALLIED SUBJECTS

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1. Manual of Entomology with special reference to Economic Entomology, by H. Maxwell Lefroy, M.A. Pp. xvi+542. (London: Edward Arnold & Co.) Price, 35*s*.
2. The Irrigation of Sugarcane in Hawaii, by W. P. Alexander. Pp. v+109. (Honololu and Hawaii: Hawaiian Sugar Planters' Association, 1923.)
3. Elementary Agriculture, by Henry J. Waters. Pp. ix+349 +6 plates. (Boston and London: Guin & Co.) Price, 5*s*. net.
4. Scientific Feeding of the Domestic Animals (authorized translation from the third German edition of Paul Fischer), by Martin Klimmer. Pp. 252. (London: Baillière, Tindall & Cox.) Price, 18*s*. net.
5. Insect Life, by C. A. Ealand. Pp. 352. (London: A. and C. Black, Ltd.) Price, 10*s*. net.
6. Practical Plant Ecology, by A. G. Tansley. Pp. 228. (London: G. Allen and Urwin.) Price, 7*s*. 6*d*.

The following publications have been issued by the Imperial Department of Agriculture in India since our last issue:—

Memoir.

1. Studies in Inheritance in Cotton, I. History of a cross between *G. herbaceum* and *G. neglectum*, by G. L. Kottur, M.Ag. (Botanical Series, Vol. XII, No. 3.) Price, R. 1-4 or 1*s*. 9*d*.

Indigo Publication.

2. Indigo Experiments, 1922. (1) The effect on produce when vat liquor is allowed to stand in the beating vat and beating is delayed; (2) the effect of neutralizing the liquor with caustic soda before beating, by J. H. Walton, M.A., M.Sc. (Indigo Publication No. 12.) Price, As. 4.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1st FEBRUARY TO THE 31st JULY, 1923

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	The *Agricultural Journal of India*, Vol. XVIII, Parts II, III and IV. Price, R. 1-8 or 2*s.* per part; annual subscription, Rs. 6 or 9*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India.	Messrs. Thacker, Spink & Co., Calcutta.
2	Annual Report of the Board of Scientific Advice for India for 1921-22. Price, R. 1.	Issued by the Board of Scientific Advice for India.	Government Printing, India, Calcutta.
3	Summary of Tables showing the total area, area cultivated and uncultivated, area under irrigation and area under different crops in British India in the Agricultural Year 1921-22. Price, As. 4.	Issued by the Commercial Intelligence Department, India.	Ditto
4	Agricultural Statistics of Bengal for 1921-22. Price, R. 1-12.	Government of Bengal, Agriculture and Industries Department.	Bengal Government Press, Calcutta.
5	Cultivation of Jute for seed ..	R. S. Finlow, B.SC., F.I.C., Offg. Director of Agriculture, Bengal.	Ditto
6	*Bengal Agricultural Journal.* (Quarterly.) (In English and Bengali.) Annual subscription, R. 1-4; single copy, As. 5.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
7	Season and Crop Report of Bihar and Orissa for 1922-23. Price, R. 1.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
8	Report on the Working and Administration of the United Provinces Government Gardens for the year 1921-22.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
9	Report on the Operations of the Department of Agriculture, Punjab, for the year ending the 30th June, 1922. Part I. Price, R. 1.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
10	Pamphlet on Orange Culture in the Punjab. Price, As. 5.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
11	Report on the third regular Wages Survey of the Punjab taken in December, 1922. Price, R. 1-2.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
12	Water Hyacinth (*Eichornia crassipes*). Punjab Department of Agriculture Leaflet No. 12. (Revised.)	Ditto	Ditto
13	Tractors and Tractor Implements. Punjab Department of Agriculture Leaflet No. 21 of 1923.	H. R. Stewart, Professor of Agriculture, and D. P. Johnston, Deputy Director of Agriculture, Lyallpur.	Ditto
14	Report on the complaints of the abnormal state of the Cotton crop in 1921. Price, Rs. 4-10.	D. Milne, B.Sc., Economic Botanist, Punjab.	Ditto
15	Graphs of Humidities and Temperature connected with the Report on the complaints of the abnormal state of the Cotton crop in 1921.	Ditto	Ditto
16	Report on the Cotton Survey of the Ludhiana District in 1920. Price, Rs. 14.	L. Jai Chand Luthra, M.Sc., Offg. Economic Botanist, Punjab.	Ditto
17	Report on the Cotton Survey of the Shahpur District in 1916. Price, Rs. 25.	D. Milne, B.Sc., Economic Botanist, Punjab.	Ditto
18	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1921-22. Price, R. 1-5.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
19	A Note on Well-boring. Bombay Department of Agriculture Bulletin No. 111 of 1923. Price, As. 8.	W. M. Schutte, Agricultural Engineer to the Government of Bombay.	Ditto
20	Report on the Operations of the Department of Agriculture, Madras Presidency, for the year 1922-23.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
21	Annual Reports of Agricultural Stations in the Madras Presidency for 1922-23. (For official use only.)	Ditto	Ditto
22	Villagers' Calendar for 1923-24.	Ditto	Ditto
23	Year Book for 1922. Price, As. 10.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
24	A Popular Account of the work of the Madras Agricultural Department.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
25	The relations existing between the Research Institute, the Agricultural Stations and the Ryots. Madras Department of Agriculture Leaflet No. 21	Ditto	Ditto
26	Bone Crushing Mill. Madras Department of Agriculture Leaflet No. 22.	Ditto	Ditto
27	The Agricultural College. Madras Department of Agriculture Leaflet No. 23.	Ditto	Ditto
28	A Scheme for the distribution of breeding bulls. (In vernaculars only.) Madras Department of Agriculture Leaflet No. 24.	Ditto	Ditto
29	The Sindewahi Furnace for Jaggery Manufacture. Madras Department of Agriculture Leaflet No. 25.	Ditto	Ditto
30	A Note on the Demonstration of Agricultural Improvements carried in V Circle (Tanjore and Trichinopoly) during the first crop season in 1922-23. Madras Department of Agriculture Leaflet No. 27.	Ditto	Ditto
31	Note on the Agricultural Middle School at Anakapalle. (In Telugu only.) Madras Department of Agriculture Leaflet No. 28.	Ditto	Ditto
32	Note on the improved methods of paddy and sugarcane cultivation. (In Telugu only.) Madras Department of Agriculture Leaflet No. 29.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
33	How to can fruits and vegetables at home. (In English and Bengali.) Assam Department of Agriculture Leaflet No. 1 of 1923.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
34	Report on the Operations of the Department of Agriculture, Burma, for the year ended the 30th June, 1922. Price, R. 1.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
35	Agricultural Calendar for 1923-24. (In Burmese.)	Ditto	Ditto
36	Report of the Agricultural Chemist, Burma, for the year ended the 30th June, 1922. Price, As 4.	Ditto	Ditto
37	Report of the Economic Botanist, Burma, for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
38	Report of the Assistant Director of Agriculture (Entomology), Burma, for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
39	Report of the Agricultural Engineer, Burma, for the year ended the 30th June, 1922. Price, As. 8.	Ditto	Ditto
40	Report on Sericultural Work for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
41	Report on the Pump Irrigation at Chaungu (Sagaing), 1921-22. Price, As. 4.	Ditto	Ditto
42	Report on the Mandalay Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
43	Report on the Allanmyo Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
44	Report on the Hopin Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
45	Report on the Padu Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
46	Report on the Yawnghwe Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
47	Report on the Tatkon Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
48	Report on the Hmawbi Agricultural Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
49	Report on the Mahlaing Cotton Experimental Station for the year ended the 30th June, 1922. Price, As. 4.	Ditto	Ditto
50	Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province for the two years ending the 30th June, 1922.	Issued by the Department of Agriculture, North-West Frontier Province.	Government Press, Peshawar.
51	Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for the year 1921-22.	Issued by the Department of Agriculture and Fisheries, Travancore.	Government Press, Trivandrum.
52	Annual Report of the Agricultural Department, Gwalior Government, for 1921-22.	Issued by the Department of Agriculture, Gwalior.	Alijah Darbar Press, Lashkar.
53	Annual Report of the Agricultural Department, Mysore, for the year 1921-22.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
54	Report on the administration of the village Panchayats and Department of Agriculture in the Cochin State for the year 1921-22.	Issued by the Department of Agriculture, Cochin.	Government Press, Ernaculam.
55	The *Journal of the Madras Agricultural Students' Union.* (Monthly.) Annual subscription, Rs. 2.	Madras Agricultural Students' Union.	Literary Sun Press, Coimbatore.
56	*Quarterly Journal of the Indian Tea Association.* Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—concld.		
57	*Poona Agricultural College Magazine.* (Quarterly.) Annual subscription, Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
58	*Journal of the Mysore Agricultural and Experimental Union.* (Quarterly.) Annual subscription, Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press, Bangalore.
59	*Indian Scientific Agriculturist.* Annual subscription, Rs. 4.	Alliance Advertising Association, Ltd., Calcutta.	Messrs. Bera & Co., Printers, Calcutta.
60	*The Planters' Chronicle.* (Weekly.) Price, As. 8 per copy.	United Planters' Association of South India, Coimbatore.	E. P. Works, Coimbatore.
	AGRICULTURAL CHEMISTRY		
61	Chemical Studies on Safflower Seed and its Germination. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 7. Price, As. 10 or 1*s.*	V. A. Tamhane, M.Sc., M.Ag., Soil Physicist to Government, Bombay.	Messrs. Thacker, Spink & Co., Calcutta.
62	Note on the Permanent Manurial Plots, Coimbatore. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VI, No. 8. Price, R. 1-4 or 1*s.* 9*d.*	Ronald V. Norris, D.Sc., Government Agricultural Chemist, Coimbatore.	Ditto
63	A Note on Hydrocyanic Acid in the Burma Bean (*Phaseolus lunatus* sp). Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VII, No. 1. Price, As. 12 or 1*s.*	F. J. Warth, B.Sc., M.Sc., Physiological Chemist, Pusa.	Ditto
64	Studies of an Acid Soil in Assam, II. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VII, No. 2 Price, As. 12 or 1*s.*	A. A. Meggitt, B.Sc., F.C.S., Agricultural Chemist, Assam.	Ditto
	MYCOLOGY		
65	*Helminthosporium* spp. on Cereals and Sugarcane in India, Part I. (Diseases of *Zea Mays* and *Sorghum vulgare* caused by species of *Helminthosporium.*) Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XI, No. 10. Price, R. 1 or 1*s.* 4*d.*	M. Mitra, M.Sc., First Assistant to the Imperial Mycologist.	Messrs. Thacker, Spink & Co., Calcutta

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	Mycology—concld.		
66	I. History of the Operations against Bud Rot of Palms in South India. II. Inoculation Experiments with *Phytophthora palmivora* Butl. on *Borassus flabellifer* Linn. and *Cocos nucifera* Linn. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 2. Price, R. 1-4 or 2*s*.	W. McRae, M.A., B.SC., Acting Imperial Mycologist.	Messrs. Thacker, Spink & Co., Calcutta.
67	Red rot disease (Saru or Soka) in thick sugarcane. Punjab Department of Agriculture Leaflet No. 18. (Revised, 1923.)	D. Milne, B.SC., Economic Botanist, Punjab.	Government Printing, Punjab, Lahore.
68	Treatment of Smut by Copper Sulphate. Madras Department of Agriculture Leaflet No. 26. (In Telugu.)	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
	AGRICULTURAL BACTERIOLOGY		
69	Some Observations on Barren Soils of Lower Bari Doab Colony in the Punjab. Pusa Agricultural Research Institute Bulletin No. 145. Price, As. 3	S. M. Nasir, Bacteriological Assistant to the Agricultural Chemist, Punjab.	Government Printing, India, Calcutta.
	ENTOMOLOGY		
70	*Platyedra gossypiella*, Saund., The Pink Boll-worm, in South India, 1920-21. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 10. Price, As. 12 or 1*s*.	E. Ballard, B.A., F.E.S., Government Entomologist, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
71	Studies in Indian Dermaptera. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 11. Price, R. 1-4 or 1*s*. 9*d*.	Morgan Hebard.	Ditto
72	Further Notes on *Pempheres affinis*, Fst. (The Cotton Stem Weevil). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 12. Price, R. 1 or 1*s*. 4*d*.	E. Ballard, B.A., F.E.S., Government Entomologist, Madras.	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title	Author	Where published
		Entomology—concld.	
73	An Account of Experiments on the Control of *Siga* (*Schœnobius*) *incertellus* in the Godavari Delta. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 13. Price, As. 14 or 1*s.* 4*d.*	E. Ballard, B.A., F.E.S., Government Entomologist, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
74	No. 1—*Hydrophilidæ* of India (Col.). A List of the Species in the Collection of the Agricultural Research Institute, Pusa (Bihar).	A. d'Orchymont.	Ditto
	No. 2—An Annotated List of Ichneumonidæ in the Pusa Collection.	G. R. Dutt, B.A., Personal Assistant to the Imperial Entomologist.	
	No. 3—A Second Note on Odonata in the Pusa Collection. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VIII, Nos. 1, 2 and 3. Price, R. 1 or 1*s.* 6*d.*	Major F. C. Fraser, I.M.S.	
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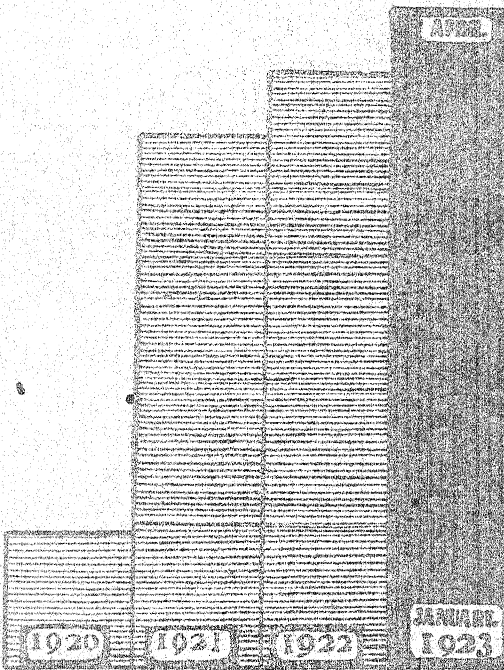

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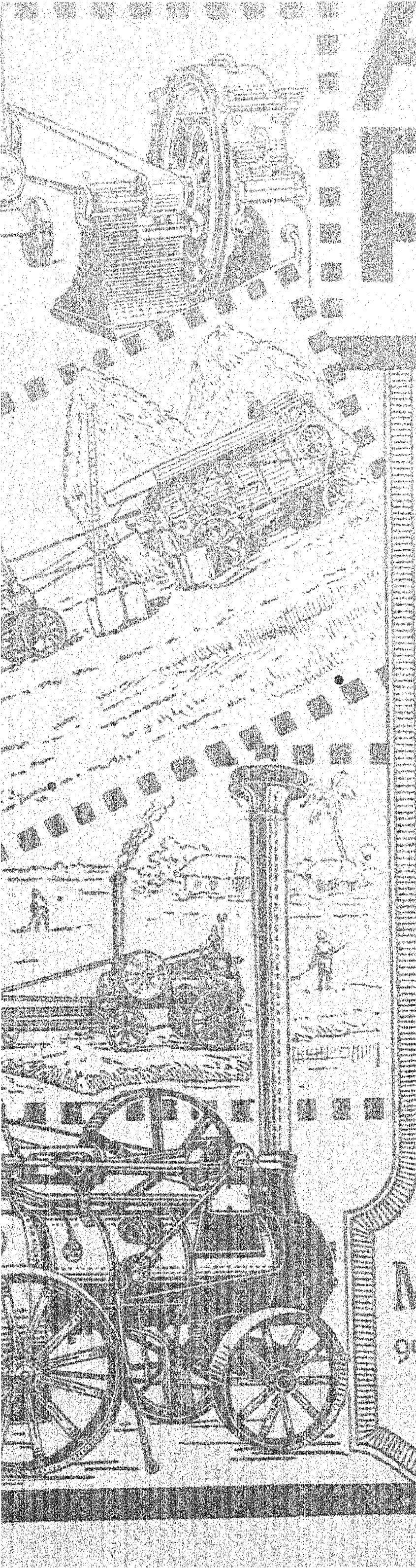

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